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MODERN LABOR-SAVING DEVICES.

BY FRANK C. PERKINS.

Fig. 1—Arrangements at Blue Hill Ry. power house for conveying material for two gravity mixers for engine and dynamo concrete foundation beds.

IT may be of interest to note some of the earlier as well as the more progressive methods of conveying the mixed concrete to the place where it is to be used as well as the modern labor saving devices including inclines, hoists and elevated tracks for supplying the necessary water, cement, sand and other material to the automatic concrete mixers now almost universally employed in large construction work.

The accompanying illustration, Fig. 1, shows the old method of employing wheelbarrow for conveying the concrete mixture from a gravity mixer, while Fig. 2 shows the horse and cart drawing the concrete from a drum type of machine operated by an electric motor by belt transmission. The former view shows how the cars are often arranged to carry the material directly to the mixing platform which is on the ground level and needing no hoisting apparatus.

The accompanying illustration, Fig. 3, shows the mixers installed in an elevated structure, the material being conveyed directly over the machines by cars passing up an incline built for the purpose, drawing Fig. 4 showing a similar arrangement supplying a cube concrete mixer, the illustration, Fig. 5, showing the inclined concrete mixing plant at the Cincinnati water works construction.

The hoisting apparatus for harbor work, with floating mixing plant is shown in Fig. 6, as used in building the Buffalo breakwater, while Fig. 7 shows the arrangement of the hoisting apparatus and method of operation of concrete mixing plant for the foundations of West Bank lighthouse in New York Lower Bay for the U. S. Government.

Modern methods for handling concrete include hoists and conveying apparatus as shown in Figs. 8 and 9, where the mixed concrete is seldom if ever touched by hand labor, the material being carried by traveling buckets to the place where it is to be used as soon as it is passed into the buckets from the continuously revolving mixer. The measuring is carried out in some cases by wheelbarrows of sand and cement in proper proportions, and in other instances by more accurate and labor saving methods.

Derricks are employed very extensively in all construction work where cement and concrete is handled, as noted in the view Fig. 10, large boxes be-

ing provided in this instance for receiving the mixture. Where electric power is available electric motors are utilized to advantage for operating the hoisting machinery, but steam power is more often used from necessity.

Among the many and important materials used by contractors in their work there is none, with possibly the exception of iron and steel, which is so universally required as concrete. In road building, in the construction of large buildings, bridges or power plants, in the construction of hydraulic works, tunnels, drainage canals, and river and harbor work, concrete is at present practically indispensable.

The solidified mass commonly known as concrete, consists of sand, crushed stone and gravel united by Puzolan, Portland natural cement. Portland cement, as produced in America, England and Germany, is defined by the corps of engineers of the United States Army as being "the product obtained from the heating or calcining up to incipient fusion or intimate mixtures, either natural or artificial, of Argillaceous with calcareous substances, the calcining the product to contain at least 1.7 times as much of lime, of weight as of the materials which give the lime its hydraulic properties. It is finely pulverized after calcination, and, therefore, additions of substances for the purpose of regulating certain properties of technical importance are allowable not exceeeding 2 per cent of the calcined product."

Portland cement, according to the London Chamber of Commerce definition, is "A mixture of two or more suitable materials ultimately and artificially mixed in the requisite proportions, and afterwards properly calcined and ground, to which nothing has been added during or after calcination, excepting that an addition not exceeding 2 per cent of gypsum is permissible for the purpose of regulating the setting. If any material whatever, excepting 2 per cent of gypsum for the purpose of regulating the setting, be added to the Portland cement clinker during or after calcination, the caricle so produced shall not be sold as Portland cement, but under some other distinctive name."

According to the definition authorized by the German Minister of Public Works, Portland cement is "a material resulting from the calcination carried to the point of incipient fusion, as an intimate mixture of lime and argillaceous substances as its essential components, such calcination being followed by the grinding of the product to the fineness of flour."

Natural cement is made in the United States and is somewhat cheaper than Portland cement, but it is not considered to possess the strength of the latter. The Puzolan or slag cement is manufactured by grinding blast furnace slag together with slacked lime, but is said never to become as hard as Portland cement, although it is considered by some engineers as tougher and less brittle than the Portland cement.

In the use of concrete one of the most important features is that the ingredients be thoroughly mixed as well as properly balanced as to the quantities of the various materials used. Even though the sand, crushed stone or gravel, and cement are carefully measured, the quantities being properly balanced, still a very poor quality of concrete will result unless there is a thorough mixing of the ingredients. The mixture of concrete is accomplished by the use of power driven machinery, and by hand, both methods giving satisfactory results as to the quality of concrete produced when the mixing is thoroughly done. Where a large amount of concrete is required the contractor usually provides labor saving machinery for mixing the concrete, although hand mixing is common where only a small amount is required. The platform generally used for hand mixing is of sufficient size to mix two batches at the same time if desired, one batch usually being used while the other is being prepared.

By mixing concrete by machinery it is claimed that there is a saving of at least one-half as compared with the cost of mixing by hand. The mechanical labor saving concrete mixing machines

may be considered under two heads, those known as continuous mixers and those known as batch mixers. The continuous mixing types may also be divided into classes, one of which utilizes power of some sort such as supplied by steam engines, gas engines, water motors, and the other type of mixer in which the work is done by gravity without the necessity of steam or other power.

The batch mixers are arranged to mix the concrete in separate charges, and all of the ingredients which are necessary for a batch are put into the mixer at the same time. Then the mixer is rotated till the mixing is complete, and the concrete which is thoroughly mixed, is discharged at one time. A new batch is then prepared and the operation is then repeated. This type of mixer is particularly favored by some engineers, as the proportions of the ingredients can be very accurately measured for each batch, and for this reason a very excellent quality of concrete is produced, the mixing being carried to any degree desired according to the period of time allowed for the mixing.

Among the well known rotary concrete mixers of the drum type should be mentioned the Ransome, the Gilbreth and the McKelvey. The accompanying illustration shows a Ransome automatic concrete mixer driven by a separate engine, or an electric motor may be employed of six K. W. capacity, a steam engine being utilized in this instance, the power being transmitted by long belts from a separate building near by. The drum mixer of the Ransome type is directly connected to a steam engine, the steam being supplied through flexible piping from a near by boiler plant.

Fig. 2.—Ransom's automatic concrete mixer driven by belt transmission and electric motor.

Portable plants are also constructed which are entirely self-contained, being equipped with both boiler and engine for supplying the necessary power. These portable batch concrete mixers have an hourly capacity of 25 cubic feet, the power being supplied by a 12 h. p. vertical engine, which is supplied with steam from a 12 h. p. boiler mounted on the same truck. This portable outfit was constructed by the Ransome Concrete Machinery Company and weighs 7,500 pounds. The Ransome Concrete Mixer revolves continuously whether charging, mixing or discharging, and

it has no movable parts within the mixing drum. To discharge, it required but twelve seconds through the simple reversal of the chute. A drum mixer was used at the work on the Metropolitan high level sewer, and special hoisting and conveying apparatus employed in connection with the drum mixer on this sewer construction work. As will be noted from the above, the portable and semi-portable drum mixers are arranged in various ways as to their driving power. In some cases the steam is supplied through long pipes, the boiler being located at considerable distance from the mixer, while the steam engine is directly connected to the drum. In other instances the engine, whether of the steam or gasoline type, is located in a separate building, long belts connecting the drum mixer or cube mixer, as the case may be; an electric motor is employed being utilized in the same way. Still another method employed in connection with portable plants, which are entirely self-contained, utilizes an electric motor, a gasoline engine, or a steam engine and boiler combined, on the same truck, the power and mixing device as well as the means of transmission of power being located together on the same frame. The steam engine and boiler outfit, combined with a McKelvey batch concrete mixer, is a portable outfit of this type having a capacity of ten cubic yards per hour. This portable mixing plant weighs 2,400 pounds and is operated by a two h. p. engine.

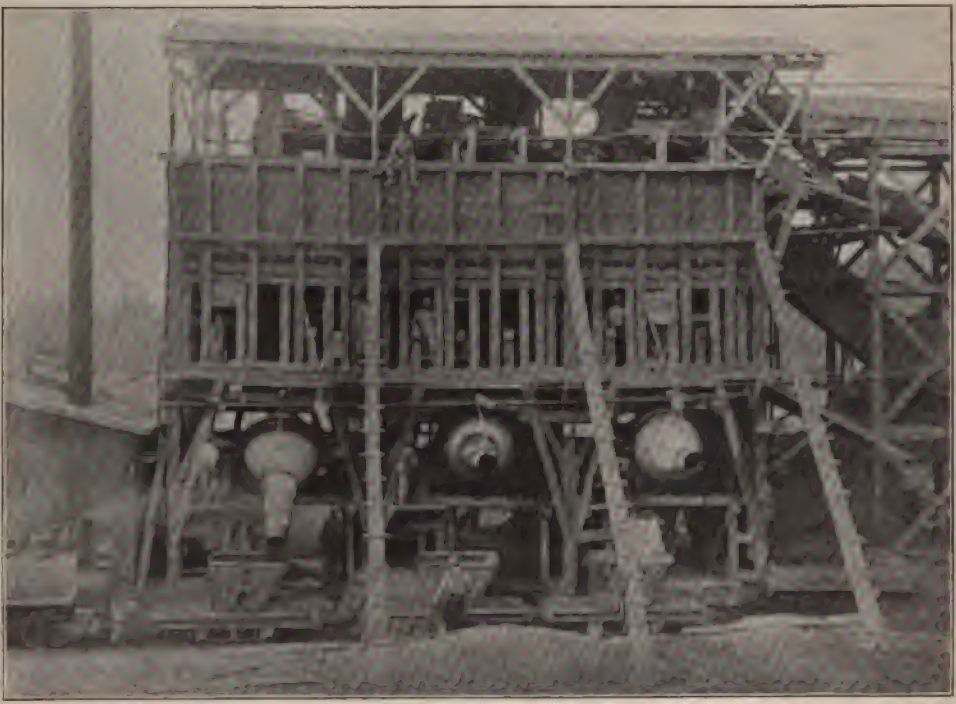


Fig. 3.—Installation employed for conveying and raising sand, cement and other material for concrete mixers at Washington filtration plant.

The largest Ransome Concrete Mixer of the portable type has an hourly capacity of 35 cubic yards, the size of batch of loose material being 52 cubic feet. This equipment has a 25 h. p. engine, boiler and automatic water tank, and is provided with a charging hopper, the feed opening of the machine being lower than that of most mixers, and the discharge relatively higher. It is stated that even when operated with a charging hopper designed to hold the entire batch, the height of feed is less

than that of most machines. The weight of the complete outfit is 7,500 pounds and the speed at which the mixer rotates is 15 revolutions per minute.

Batch Mixing Types.

There seems to be considerable difference of opinion among the leading contractors and engineers as to the quantity of water to be used in the mixing of concrete. Some engineers are of the opinion that sufficient water should be used as will require little ramming to be done in handling the concrete. A wet mixture of this sort is said to be produced by using about four cubic feet of water for each cubic yard of concrete. While some contractors advocate the free use of water others are inclined to use it sparingly.

The same difference of opinion exists as to the type of mechanical mixing machinery to be employed. Many engineers are strongly in favor of the continuous mixing types of machines, while other equally prominent men hold that the batch mixers produce a more even and high grade concrete, as each of the ingredients are carefully measured for each batch, and the whole may be mixed as thoroughly as desired by continuing the operation of the mixer until satisfied each batch is perfectly mixed.

Among the various batch mixers constructed abroad is one built by S. Pegg & Son of Leicester, England, which is said to mix the material very satisfactorily. A vertical cylinder is provided with a vertically rotating shaft upon which the mixing blades are fixed. The shaft is driven by bevel gearing from below, and a small door is provided on the side of the mixer from which the concrete issues, the ingredients being charged at the top.

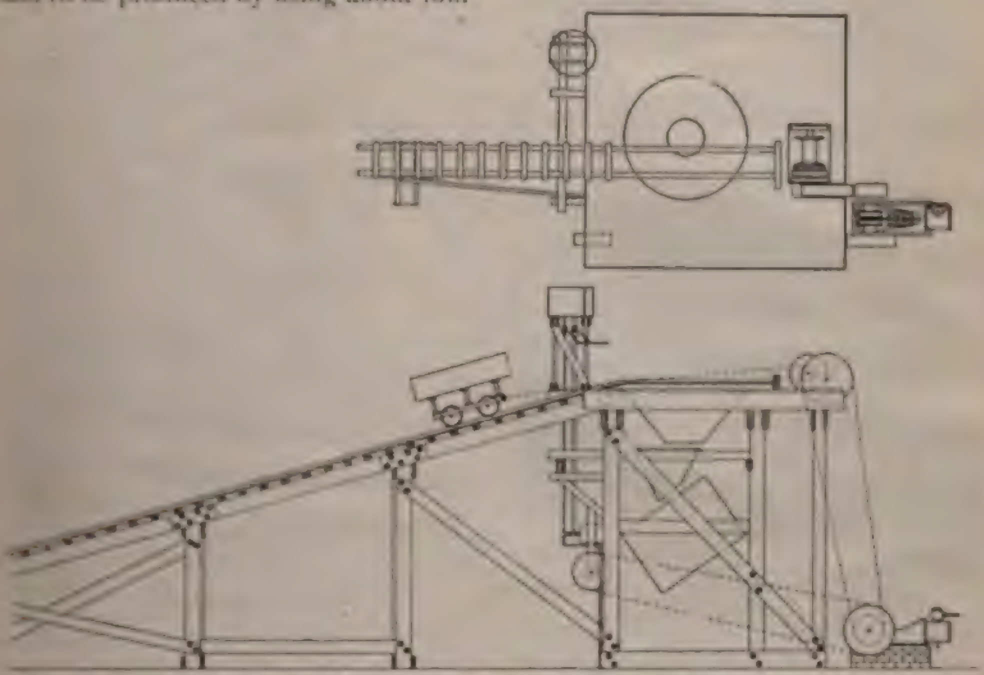


Fig. 4.—Details of hoisting and inclined concrete mixing plant.

Another type of batch mixer is constructed by Julian School & Co. of New York, in which the mixing is effected by oblique blades or teeth on two horizontal parallel shafts which are revolved in opposite directions, thus constantly working the material from all sides to the center, whence it is discharged by a slide in the bottom. The other principal types of batch mixers and those most extensively employed are the cube mixers and the drum mixers, details of

these types as constructed in America being shown in the accompanying illustrations.

In the School batch mixer above referred to, the sand, cement, stone and water are all charged into the mixer at the same time and retained there until thoroughly mixed, the time allowed being generally from one to one and a half minutes. The sides and bottom of the machine are made of steel plate; the heads of cast iron, strong ribbed. The shafts are of steel, square cross section, and as the teeth are fastened on them by bolts clamping around the shaft, the full strength of the latter is maintained. The teeth are of chilled charcoal iron, which is very tough and hard. They are made of round ends, which prevent the stone wedging between the teeth and the steel lining of the machine.

Fig. 5.—Inclined concrete mixing plant at Cincinnati water works, using cube mixer.

The heads are fitted with removable plates directly over the shafts, held in place by four cap screws. On removing the screws and the bearing box caps, the shafts (with all the gears, teeth and collars) can be lifted vertically out of the machine. The bearings are heavy and set out from the heads of the brackets. The steel sides are protected from wear by liners of 1/4-inch steel held in place by countersunk machine screws, permitting easy renewal of the liners. The contents of the machine are discharged through a large opening in the bottom, covered by a cast iron slide operated by a hand lever. The mixer is driven by either spur gears or link belt.

The mixing in cube machines is done in the most thorough manner without the aid of any moving parts, such as paddles, shelves or discs in the cubes where the mixing is done.

The mixer proper is a cube which is built up of sheet metal securely riveted to angle irons and this cube is mounted through one diagonal on a hollow shaft, being secured to the same by having cast iron trunions. This shaft is perforated on the inside of the cube for the water supply. Some of the standard machines of this type are fitted with large worm gears mounted on hollow shafts near one end, which is driven by a worm. In this machine the worm and gear are mounted in a self-contained dust proof, self-oiling casing to insure alignment. The worm shaft is supported in the worm case bearings and also on two bracket bearings, and carries a friction flush pulley. The engine is run continuously and is independent of the action of the mixer, which is started or stopped by means of the friction pulley. A portable cube mixer was used in the construction of the Walworth sewers in Cleveland, O. This machine, it will be noted, employs a single hopper which racks back and forth on the track-ways provided on a steel frame. The door is fitted in the bottom of this hopper and in this case the material is loaded into the hopper by means of a cable way. On the steel frame a vertical engine is mounted, connected to the cube with spur-gearing and a friction clutch. This particular cube mixer is picked up with a derrick and placed wherever desired, but these machines are also constructed, as noted in diagram, mounted on wheels, making it a complete portable outfit for street work. A horizontal engine is shown in this case belted to the mixer.

It is frequently desirable to supply the material for making the concrete through the mixers by elevating cars to the platform on an incline, as shown in the accompanying illustration. A number of the plants utilizing this manner of conveying the materials to the cube mixers have been installed by the con-

tractors on the Cincinnati water works. A friction clutch belt hoist is operated by the attendant on the top of the platform, the hoist being driven from the same engine which operates the mixer.

With these cube mixers, constructed by Kalkenback & Griess of Cleveland, O., the watering tank is provided with a special arrangement of valves so that the quantity of water is positively discharged for each vat, no matter how little or how much water to the full capacity of the tank is required.

The four-foot cube machines of this type are designed to mix single batches of one cubic yard, and the five-foot machines to mix batches of two cubic yards, while the capacity per hour or per day for these machines depends on the conditions and facilities for charging the hoppers and disposing of the material after mixing. The mixers usually handle from 150 yards to 275 yards in ten hours, according to the size of the cube.

For harbor work it is frequently necessary to employ floating mixing plants, as for instance in the construction of docks and breakwaters such as the floating concrete mixing plant used by the Buffalo Dredging Company in building the Buffalo breakwater. Revolving cantilever cranes are also frequently utilized in connection with this work, the crane being mounted on the mixing plant on the scow. An outfit of this type was utilized in the construction of the Cleveland breakwater, the crane having a capacity of three tons at 50 feet radius, and handling all the material to the mixer as well as all the concrete from the mixer. This plant was principally for making large concrete blocks weighing from 15 to 20 tons each. Cable ways are also extensively used in connection with mixing plants, at the Cleveland breakwater, a Lidgerwood cable-way being employed for taking the old stone out of the breakwater to the crusher and also for handling the concrete from the mixer to the breakwater.

Fig. 6.—Hoisting and floating concrete mixing plant used by Buffalo Dredging Co. in building Buffalo breakwater.

Another separate portable cube mixer is constructed by the Municipal En-

gineering Contracting Company of Chicago, Ill. This machine is mounted on a truck and is self-contained, being equipped with a boiler as well as an engine of the required power for driving the mixer. An accompanying view shows the cement mixers at the Washington filtration plant.

Portable Gravity Concrete Mixers.

The following suggestions and data for testing cement as given by the Vulcanite Portland Cement Company, are made as general and free from technical terms as possible in order to be more readily understood by the laymen. An eight foot length of portable gravity concrete mixer was arranged for mixing concrete for a foundation for the West Bank lighthouse, New York, Lower Bay, for the United States Government, and a gravity concrete mixer with stationary platform was used on the Montreal harbor improvement. One steam derrick is for conveying the ingredients and dumping them into a hopper over the mixer, and the other steam derrick is for conveying the mixed concrete away from the mixer. The little truck under the mixer is used for bringing the empty box under the mixer when the full box is being removed.

The object of testing cement is to ascertain its value as a building material, by determining whether it meets certain specified requirements. In case of failure of the shipment to meet the seven days requirement, it should be held to await the results of twenty-eight-day test. Care should be exercised to protect the shipment from weather pending the results of these tests. As the methods of testing cement are not infallible, and since the "personal equation" of the testor renders the results of such tests not only relative but frequently inaccurate, the cement should, in event of failure, be given a re-test. The test to which cement is subjected should be of the simplest character, even where the best facilities for making such tests are avail-

Fig. 7.—Hoisting equipment and method of operation of 8 ft. length portable gravity concrete mixer on foundations of West Bank Lighthouse, New York Lower Bay, for U. S. Government.

able. The best methods of selecting the sample, the termination of fineness, of the proper percentages of water to be used, time of setting, tensile strength and consistency of volume, are very important. In reference to fineness, it is stated that coarser particles in cement are generally considered inert and devoid of hardening quality. The more finely a cement is pulverized, the greater will be the quantity of sand that can be mixed with it and produce a mortar of given strength. It is usual to determine the percentages of fine and coarse by measuring by weight the residues on certain standard sieves, usually those are known as the number 100 and 200. These sieves have about 10,000 and 40,000 meshes per square inch, and the wires have diameters of .0045 and .0025 of an inch respectively. In specifying a fineness for cement, the size of wire and the number of meshes per inch should also be stated. The sieves are made of brass wire cloth, and the frame, usually of brass, is from six to eight inches in diameter, two and one-half to four inches high, provided with pan and cover. About 100 grams of cement thoroughly dry at 212 degrees Fahrenheit, make a convenient quantity to sieve. The operation of sieving is best accomplished by hand method, and is complete when no more than one-tenth of one per cent passes through the sieve after one minute continuous sifting. The result should be noticed to the nearest tenth of one per cent.

As to normal consistency, it is suggested that the percentage of water to be used in making tests for time of setting, strength, and pats for consistency of volume is of the greatest importance. The aim should be to mix each cement with sufficient water to obtain a paste having the same degree of plasticity or to produce what is known as the normal consistency. Different brands of cement will require different quantities of water, and even different shipments of the same brand at different seasons of the year vary as to the quantity of water required. It is claimed that with the average cement tester a very plastic mortar will yield higher and more un-

Fig. 8.—Ransome drum mixer, showing methods of operation with steam engine.

iform results than a dry mortar. A very plastic mortar can be mixed much more readily but the pats should not, however, be so wet as to permit shrinkage of the briquettes after moulding. The cement should be mixed under uniform conditions, hand method yielding the most uniform results; 500 grams should be used for the determination of normal consistency. This quantity of cement is placed on the mixing slab or table, and a crater formed in the center, into which a trial percentage of clean water is poured. The material on the outer edge of the crater is turned into the center and when the water has been absorbed by the cement the mixing is completed by kneading the mass vigorously with the hands for one minute. The process of kneading is similar to that used in kneading dough. The cement having been worked with a trial percentage of water to a plastic paste rolled into a ball about five centimeters in diameter, by tossing from hand to hand about half a dozen times. The ball is then allowed to fall from a height of one foot, and to be of proper consistency, should not flatten materially or crack. The determination of the rate of setting is a test of much practical value and this is determined by measuring the time which elapses from the moment water is added till the cement paste ceases to be fluid and plastic, called the "initial set," and the moment when it has acquired a certain degree of hardness called the "hard set." The setting of cement is the hange from a plastic condition to a solid state, and when the cement has set, the process of hardening is said to commence. The relative degree of hardening at any age is measured by determining its transverse, compressive, adhesive or tensile strength in pounds per square. The more general practice it is stated is to measure the tensile strength only, and test pieces known as briquettes, having a section at the breaking point of one square inch, are used for this purpose. These test pieces are made of cement mortar, preserved in moist air for 24 hours, then immersed in water maintained at about 70 degrees Fahrenheit and broken at intervals of seven to twenty-eight days, and other longer periods of time as desired. For testing the tensile strength eight of the Fairbanks, Riehle or Olsen machines are used, the former of these machines being preferred for inexperienced persons, because of its being more nearly automatic. The French system of weights and measures is most convenient to use because of the relation between the gram and the cubic centimeter. Another important test which is most diffiicult to make, is the consistency of volume. While it is important that cement should attain a great strength in a very short period of time, it is far more important that it should mainain its strength. Evidences of unsoundness are usually revealed by swelling, checking, cracking and disintegration, and a cement which shows none of these defects is said to be of constant volume.

The mixing action of pins and deflectors of the portable gravity concrete mixer is caused by deflectors or blades, each throwing the falling materials toward the opposite side of the mixer. Each column of falling material is intercepted by columns from the other deflectors. The mixing action caused by each pin is also shown as it divides the materials, striking it into two columns, one going to the right and one going to the left of the pin. Each of these columns is thrown violently at a column or stream of material coming from an adjoining pin or deflector in the same row. These various united streams are again divided by the next row of pins. The accompanying illustration shows the top of a gravity mixer set up in a room ten feet square, the space required for the gravity mixer, being four square feet. At the top of the trough the pins in the upper row are spaced nearer together than the pins in the other rows in order to exclude stone larger than the desired size. Other illustrations and drawings show the portable gravity continuous mixer constructed at Boston, Mass., by the Contractors Plant Company.

This form of concrete mixer requiring no power, is said to be particularly for use about mines and in mountain-

n sections where the cost of power excessive and it is difficult to trans- rt heavy machinery. It is also said be of special service on small con- cts where large machinery could rdly be used with economy, and where erwise hand mixing would have to resorted to. On account of the en- e absence of any form of power, grav- being employed to do the mixing, it said to be most economical in its oper- ons, and is employed on various ex- sive work, producing when properly elled, very high grade of concrete.

water is led from a barrel by a 1½-inch hose to the spray-pipes. The man at the bottom of the mixer, who can best see the concrete, operates the water valve. The water from the spray pipe strikes the mixer at about midway of its length. By this arrangement the concrete is mixed dry in the upper half and wet in the lower half. It is claimed for this mixer that concrete, in rolling over and over on the bottom of the steel trough ten feet along, each and every stone being thrown from side to side by each row of pins, is mixed better

Fig. 9.—Hoisting and conveying apparatus for concrete work with drum mixer on metropolitan high level sewer.

As will be noted in the drawings and strations, this mixer consists of a ort steel trough filled with numerous ws of steel pins, staggered to mix oroughly the sand, cement, and oken stone that are to compose the ncrete as they gravitate through the ugh. At the upper end of the ugh the pins in the first row are aced nearer together than the pins in e other row, in order that the stone ssing the first row will go through the st of the mixer without clogging. The

than it is possible to mix it by hand or steam. The trough delivers the concrete in any receptacle, when it can be removed as desired.

A portable gravity concrete mixer was used on the contract work of the Coliseum building at Chicago, and the same type of mixer with an eight-foot length was arranged for use on the foundations of the passenger station of the Pittsburg and Lake Erie Railroad. The capacity of this mixer is said to be governed by the quantity you can feed

to it and the amount of mixed concrete you can remove from it, as it is portable and can be shifted from place to place and hung over the trench where the concrete is to be used, there is considerable saving in conveying the mixed concrete away from the machine. Two of these mixers were employed at the power station for the Bluehill Street Railroad and constructing the foundations for the building, chimney and engine beds entirely of concrete. An interesting arrangement for accurately measuring and feeding the ingredients to the mixer was employed in the construction of an addition to the plant of the Boston Manufacturing Company at Waltham, Mass., while the accompanying drawing shows the details of the accurate measurer and mechanical feeder which supplied the aggregates of concrete through the mixer at a rate of two cubic yards per minute.

On the top of the structure, consisting mainly of two supporting posts, is situated a self-contained apparatus which measures and feeds cement, sand and gravel, or broken stone, as they flow from their respective bins, C1, C2 and C3, which are located directly above the measuring and feeding apparatus. The proportions of the aggregates can be varied at will by raising or lowering the gates, D1, D2 and D3, to the several chutes, E1, E2 and E3, through which the aggregates flow out upon the large revolving drum, G. The drum G forms a moving bottom to the chutes E1, E2 and E3. It revolves and carries the stream or layers of aggregates, F1, F2 and F3, which falls from the drum into a concentrating hopper, K. The concentrating hopper empties at its lower end into the concrete mixer, H. The apparatus is easily operated by one unskilled laborer.

Fig. 10.—Hoisting materials for supplying portable gravity concrete mixer at Montreal harbor improvements.

To operate the feeder the gates of the chutes are set for the given proportions

the aggregates. The bins are filled any desired means, according to the ditions that obtain upon the work. aggregates flow out several inches it not enough to fall off) upon the surface of the drum, which is large ugh to form a comparatively flat face under each chute. The wagon (or other conveyor) is brought under the concrete mixer. Upon receiving the signal from the man below, the laborer turns a crank which revolves the drum, causing the aggregates to fall into a concentrating hopper which empties into the mixer.

LUBRICATION AND FRICTION IN STUFFING BOXES.

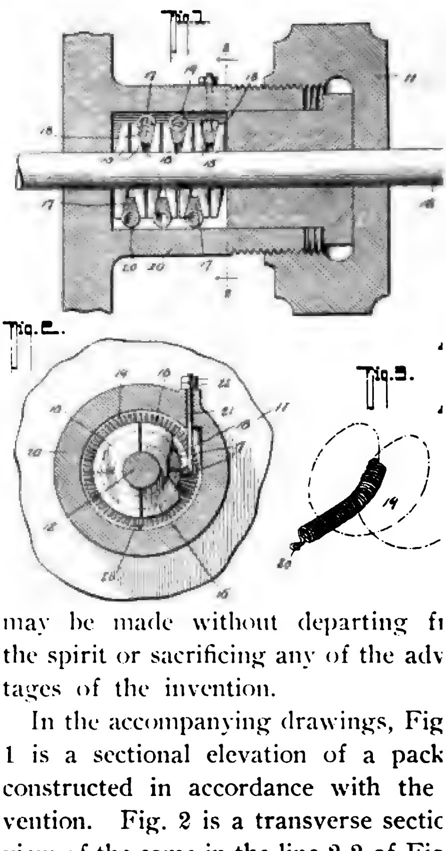
By Ralph Scott.

FRICTION is defined as that force which acts between two bodies at r surface of contact so as to resist r sliding on each other. The ratio the force required to slide a body ng a horizontal plane surface to weight of the body is called the efficient of friction. It is equiva- to the tangent of the angle of se, which we know is the angle of ination to the horizontal of an inclined ne on which the body will just over- ne its tendency to slide. The angle is ally denoted by θ, and the co-efficient $f = \tan\theta$. While the force required move a body sliding is called the fric- n of rest, and the force to keep it con- ally sliding is called the friction of tion. Refer thus to a piston rod in tuffing box. The steam is turned on the force or co-efficient of friction is ught in vogue. Then next we have friction of rest and motion, then roll- friction. Friction decreases materi- with velocity, is very much greater minute velocities of ..., falls very ly with minute increases of such ve- ties, and continues to fall much more ly with higher velocities up to a tain point, and follows the laws very ..., which obtain to lubricated fric- tion. Therefore the faster an engine goes its piston rod friction is decreased, but refer to Fig. 1. We have a piston rod packing ring made in units of two pieces, and over these units is a coiled spring. This packing not only increases the friction, but tends to wear itself out There are different kinds of packing, however, and in Fig. 2 shows a packing that compensates for wear, it having an adjustable nut inside the box. This is a new invention, of which a perfect de- scription is given. This packing device can be made in two forms, with or with- out the adjusting nut, and have in its stead a separate spring over each wedge be- tween the rings which is continually passing the packing in position around and along the piston rod and gland. In order to reduce fric- tion, whereby friction may be reduced, it is essential that its nature, cause and effect be understood. As its nature, it is simply a resistance to the motions of moving parts of the body in contact with one another. Friction is reduced by lu- brication, and are divided into three gen eral classes, known as fluid, plastic and solid lubrication. The first takes up all oils, second the greases. Thirdly the class includes solids as have been used

for lubricating, such as graphite, which fills irregular surfaces. Metals, though highly finished, still have uneven surfaces, and cannot be felt by the hand or seen with the naked eye. Perfect lubrication prevents contact entirely, but this is not realized in practice. More or less contact by surfaces caused by wear. Lubricants must have no dirt or grit of any kind or they cut into the bearings. Since lubrication forms a layer between the surfaces, and it goes to show that in order to do this successfully the lubricant must have body of cohesion enough so as not to squeeze out the lubricant. They should not evaporate under heat. Plastic lubricants come under various kinds of greases, and are made by mixing fats and oils together till they become somewhat like lard. Any packing device that does not provide for lubrication cannot fill near enough the necessary qualifications for practical purposes.

A common style of packing.

In Fig. 2 this device not only allows for wear and tear, but provides in and between each packing ring a space for waste, to which lubrication is continually being supplied by the rod on its return stroke. Then, too, it has for its principal object to provide a novel form of packing adapted especially for the use in connection with piston rods. A further object of it is to construct a packing which may be readily adjusted when worn out without opening the stuffing box and without turning the gland nut. A still further object of the invention is to provide a novel form of packing which can be adjusted circumferencially as well as pressed longitudinally. ' arrangement consists in certain n features of construction and arrar ment of parts hereinafter fully descril illustrated in the accompanying drawi and particularly pointed out in the pended claims, it being understood 1 various changes in the form, proporti size and minor details of the struct



may be made without departing fi the spirit or sacrificing any of the adv tages of the invention.

In the accompanying drawings, Fig 1 is a sectional elevation of a pack constructed in accordance with the vention. Fig. 2 is a transverse sectic view of the same in the line 2 2 of Fig Fig. 3 is a detail perspective view of adjustable helix for exerting press circumferentially of the packing.

Similar numerals of reference are ployed to indicate corresponding p: throughout the several figures of drawings.

The stuffing box 10 is of ordin construction and is provided with a gl nut 11 for compressing the packing the direction of the length of the pis

od 12. Arranged within the stuffing ox and encircling the piston rod is a ectional helix 15, formed of any suitable etal, the adjacent walls of said helix eing inclined to form tapering openings 6, that are approximately V-shaped. he sections of the helix are each approximately semicircular and when in osition a continuous tapered helical hannel is formed. In this channel is laced a second helix 17, the contour of hich corresponds to that of the helical ecess, and this second helix forms a edge which, when the members thereof re forced inward in the direction of the iston rod, will bind the sections of the acking helix 15.

The outer faces of the sections of the elix 17 are provided with curved rooves or channels 18 for the reception f an adjusting helix 19, which may be ormed of a helically-wound coil of ire. One end of the adjusting helix s secured to a fixed support 20 within the stuffing box, and the opposite end thereof is connected to an eyebolt 21, that extends out through an opening in the stuffing box and receives an adjusting screw 22 at a point outside the box. When the packing is to be adjusted, the nut 22 is turned in one direction or the other, and by tightening the nut the adjusting helix may be clamped more firmly around the helix 17 and the members of the packing pressed firmly together. In addition to this circumferential adjustment tending to evenly compress the packing around the piston rod said packing may also be adjusted not only by tightening of its circumferential band, but also in a direction of the length of the piston rod.

While the invention has been described as applicable more especially to piston rods, it will be understood that it may also be employed in the packing of various devices without departing from the invention.

ESCAPE FROM FIRE MADE A JOY.

To be carried to the streets on flowery ods of ease from a theater fire is the appy destiny of those who use the new Hasselhardt fire escape. He proposes o remove the pit en bloc with the oxes attached to it, as well as the partition walls into the street by means of ollers underneath the floor, running ver a track of rails continued to a suitable length outside the theater, the cheme also allowing for the simultaneous rescue of people in the balconies bove by exits through specially constructed window doors opened automatically all at once, and leading to suspended galleries which are lowered to the street by the same mechanism actuating the moving pit. The theater is thus emptied from gallery to pit in half a minute, whether the audience numbers five or 5,000. The galleries are suspended on hinges from heavy outriggers, which act as powerful single arm levers and turn around pivots fixed below the first balcony. On being lowered all the outriggers and the suspended galleries move to the side and descend to the street. The gearing is so arranged that at the moment the outrigger galleries touch the street the whole pit has been removed from the theater building.

Interesting Case of Weathered Gravel Slope.

R. N. Kinnaird.

The accompanying photograph shows a gravel slope of about two years weathering in the L. E. & W. gravel pit at Lafayette, Indiana. The stakes "A. A." were set level thus determining the horizontal line in the photograph, from which the slope of the bank was determined directly. An instrumental determination of the same slope showed 1.475 to 1. The slope in the background shows 1.373 to 1, being slightly less weathered and coarser gravel.—Engineering Review.

HELPFUL KNOWLEDGE ABOUT ELECTRICITY.

By Edmund B. Moore,

Author of "Wire and Wireless Telegraphy."

PART V.

IN the theory of electrical induction lies the principles of much of the electrical apparatus which has proven of unlimited value, and which in the advancements of this twentieth century we could not, in any sense of the word, do without. The process of induction is perhaps one of the most wonderful phenomenas produced by the electric current. Just what actually takes place in the inducing of electrical currents is still a mystery but we know what its effects are and have established theories which, no doubt, are correct so far as the present scientist has been able to find out. Although there is occasionally brought to light some new discovery which for a time almost contradicts the long established laws and accepted theories.

In December 1824, Michael Faraday, a noted electrician, philosopher and chemist made several experiments by

means of an electro magnet. He also made attempts to produce an electric current in one wire by the effects of another wire also carrying an electric current. All of these, however, were unsuccessful from the start. Faraday although many times discouraged was not the man to give up without giving it many similar trials. In the latter part of the year 1831, he obtained practically the first evidence that an electric current can be made to induce another in a different circuit.

If a coil of wire is connected to a galvanometer and a fairly strong magnet is thrust into the coil, the needle of the galvanometer will be slightly deflected, showing that a weak electric current passed around the coil as the magnet was inserted. By bringing the magnet at rest inside of the coil we find that there is no movement of the needle whatever, but upon drawing it out again the needle of the instrument is deflected in exactly the opposite direction from that in the first case. This shows that by drawing the magnet out of the coil of wire the electric current flows through the coil in exactly the opposite direction from which it did when the magnet was inserted. No current, whatever, flows when the magnet is at rest.

Fig. 9.—Rhumkorff Coil (small size).

What exactly takes place in this experiment is not definitely known. But when in any conductor the number of lines of force passing through the closed circuit undergo a change, small or great, an electric current is induced in this circuit. When the number of lines of force increase the current flows through the circuit in one direction and when they decrease the current will flow in exactly the opposite direction.

We know that a magnetic field exists around a magnet and by moving it in or out of the coil, makes an increase and decrease in the number of lines of force, producing electric currents in opposite directions whose rate varies with the movement of the magnet. If the movement of the magnet is very rapid the current alternates in the same rapidity. A current, as in this case, which flows first in one direction and then in another is called an alternating current.

It is not absolutely necessary in producing the induced current to have the conductor move itself. An electric current is produced in a conductor when the lines of force are cut, and this cutting may be caused by the motion of the conductor itself, or by the motion of the lines of force.

So, in the experiment with the coil of

wire connected with the galvanometer, the magnet may remain stationary and the coil of wire move forward and backward over the magnet. The direction of the current will be one way when moved forward over the magnet, and in the opposite direction when drawn backward.

The direction of the current produced in the coil when the magnet is thrust into it is opposite from the direction of the hands upon a clock, and when the magnet is withdrawn the direction is reversed and is the same as the hands of a clock.

This coil of wire, traversed by the electric current acts similar to a solenoid and tends to stop the motion of the magnet which is moving in and out of the coil. Whenever an induced current is made by the motion of a magnetic field the field belonging to the induced current tends to stop the movement of the original moving field from which the induced current itself was made.

We know, as has been previously explained that a wire carrying an electric current possesses a magnetic field around it. In the last few experiments described the lines of force belonging to the coil of wire, connected with the galvanometer, were cut by the lines of force of the moving magnet. Now if a wire carrying an electric current, which also possesses a field of force, is moved towards and away from a wire or other conductor, an induced current will immediately be set up in the stationary conductor or wire. This is because the lines or force, which belong to the wire carrying the electric current, cut the wire or conductor which is at rest and an electric current is at once set up within the conductor itself.

This shows that an induced current may be produced in a circuit by the lines of force from other means than a magnet, as was used in our first experiment. The wire carrying the electric current in this last experiment was not in any particular shape, a straight wire being used. We will now substitute for this straight wire a comparatively small sized coil which, carrying a strong electric current, we will thrust into a somewhat larger coil, the two ends of this larger coil being connected to a galvanometer.

Upon thrusting the smaller coil or Primary as it is more often called, which carries the electric current, into the second coil or Secondary, an induced current is at once set up in it in one direction and upon removing the primary coil an induced current is also set up but in the opposite direction from the first, as the needle of the galvanometer would indicate. The current in the secondary coil is in the opposite direction when the primary is removed because the lines of force are cut in exactly opposite direction.

When the motion of the primary coil ceases, of course, there are no lines of force being cut and as we must have the lines of force in a conductor cut to produce an induced current, then no current whatever will flow in the secondary while the primary is not in motion, unless the lines of force are somewhat increased or decreased by other means.

As in the case of the coil and the magnet it is not necessary to have the primary move. The primary may remain stationary and the outside coil move forward and backward over the primary. The induced current will then be produced in the latter in the same way, flowing in one direction when the coil is moved over it, and then flowing

in the opposite direction upon its removal.

Experiments have proven that by increasing and decreasing the number of lines of force in the first coil, although it remains stationary the lines belonging to the magnetic field of the current in the primary coil will cut the conductor of the secondary and, of course, produce an induced current.

This induced current in the secondary is produced only while the lines of force in the primary are increasing or decreasing. Now by having the primary coil remain stationary within the secondary and by opening and closing the circuit of the primary, increases and decreases the lines of force which cut the conductor of the outside coil and sets up induced current as in the numerous cases above described.

When the circuit is closed in the primary coil the lines of force are very rapidly raised from naught to their height and as the circuit is broken the lines of force are quickly reduced again It is during this change the increasing and decreasing of the lines of force which cut the conductor of the secondary that the induced current is produced. This is called Self Induction. By taking the two ends of the wire which are. of course, in series with a good strong battery and touching them together rapidly a bright spark will be seen This is caused by the self induction of the coil, which upon breaking of the circuit produces a very high electromotive force, which causes the bright spark to follow.

The fundamental principles of electric induction should now be clear in the reader's mind and the practical workings of inductive apparatus should be partially understood.

An instrument constructed for the production of induced currents wherein the previously described laws and theories are carried out, is commonly called an induction coil. If the reader will stop a moment he will recall the facts which were given in part 1 of this series, that static or frictional electricity was produced by a machine called a static machine, in which it was necessary to apply some form of mechanical power to produce motion of the plates.

With the aid of the induction coil a very weak current may be increased to a current having a high electro-motive force (E. M. F.) The increase of the original current, however, depends upon the size of the coil used. The induction coil in its simplest form may be divided into four separate parts, the primary coil, the secondary coil, the soft iron core and the viberator.

The primary coil consists of two or three layers of number fourteen double cotton covered magnet wire. The size of the wire will vary in different sized coils. This wire is wound in smooth layers upon the core, which is separated from direct contact with the wires by a number of turns of shellaced paper.

The core itself is made up of a bundle of soft annealed iron wires, commonly called "stove-pipe wire." These are bound tightly together and are soldered at the ends. This style of core is used because it has been found by experiments that it produces better magnetic effects and greatly increases the induction than would be the case if a solid core was used. Eddy currents would also occur in the solid core, which would tend to reduce the efficiency of the coil.

The secondary coil is now wound upon the primary after being insulated by a number of turns of shellaced paper. This coil is entirely separate from the first in regard to electrical connections.

thick separates the primary from the 275 lbs. of No. 36 double silk covered wire which makes up the secondary. The discharge from the coil is deafening, resembling the reports made from a machine gun. This piece of apparatus is unequalled in workmanship and it stands a monument for the highest type of electrical engineering.

A piece of electrical apparatus wherein the process of induction is used is commonly known as a transformer. These are somewhat similar in their actions to the ordinary induction coil and are divided with regard to their work into two classes: the step up and the step down transformer.

The step up transformer is used, as its name would suggest, to raise a current of high strength and low E. M. F. to a current of high E. M. F. and low strength. The step down transformer is the kind which is most used reducing a current of high E. M. F. and low strength to a current of great strength and low E. M. F. Transformers are used in the transformation of electrical power from the source of supply to the various places where it is to be used either for power, lighting or whatever it may be.

In sending the electric current great distances it will be readily seen that the resistance offered by the great length of wire will be considerable.

Copper wire is used altogether in electrical transmission because its resistance is very low compared to other metals. It will be clearly understood that if the wire used to carry the current is of exceedingly high resistance that by the time the current has reached its destination the strength of it will be greatly diminished and would not be sufficient for commercial purposes.

This may be overcome by increasing the size of the wire, which according to Ohm's law will reduce the resistance That is, if we double the size of the wire the resistance is halved.

Now in sending of commercial electric current it will be seen from the above that a very large copper wire would be necessary in order to produce the required amount of current at the further end of the line. The high price of copper destroys this theory as a commercial success on account of the great expense which would be envolved by the great size and length of the line wire.

Instead of using this large size copper wire and lowering the resistance, which would allow a moderate current to flow without much loss, just the reverse is done. That is, a comparatively small wire is used which, of course, has a high resistance and a current of very high E. M. F. and low strength is forced through the line. A current of very high voltage and low strength can be economically carried through a line of great distance, but it is necessary for power and lighting purposes that a current of great strength and low voltage be used.

To obtain this aim the transformer is placed at the distant end of the line and the high voltage current is changed or transformed by the use of the stepdown transformer into a current of great strength and having a voltage which will not be dangerous to life when it is carried into buildings.

The transformer consists of two coils of wire, the primary and the secondary. These two coils are wound upon a soft laminated iron core which is usually in the form of a ring making a complete path for the magnetism which is set up by the current in the coils.

In the step down transformer the primary coil consists of a great num-

ber of turns of wire which are connected direct to the alternating high voltage line. The secondary coil consists of a lesser number of turns and is connected to the house or local circuit. The raito of the number of turns in one coil to the number of turns in the other is the same as the high voltage current is to the desired current of the secondary, that is, if we have a transformer whose primary coil consists of one hundred turns of wire and the secondary one half that number or fifty and a current of 2,000 volts in force is fed direct to the primary coil, the effect produced in the secondary will be the voltage of the primary current divided by two and the strength multiplied by two. In the step down transformer, the voltage will be reduced and the strength increased in proportion to the construction of one coil to the other.

If we use for the primary coil the one of fifty turns of wire and the secondary of 100 turns, then the induced current which will be obtained from the secondary will be twice as strong in voltage, but one half as weak in strength. By the arrangement of the turns in the two coils any current may be raised or lowered as the case may be.

The transformer is a wonderful electrical instrument as there is no mechanical motion whatever concerned in its operation.

It will be recalled that with the induction coil the increase and decrease of the lines of force, which are necessary to cause an induced current, were caused by the interrupter. In the transformer no interrupter is needed because the original current which is fed to the primary coil is of itself an alternating current. These alternations producing the increase and decrease of the lines of force in the primary coil, which as has been explained, cut the conductor of the secondary and produce the induced current. This induced current in the secondary will be an increase or a decrease over the primary current according to the increase or decrease of the turns of wire in the secondany over the primary.

The two coils of a transformer are usually incased in an iron box which protects the coils from outside injury and also allows the two coils to be surrounded by a heavy parafine oil which increases the insulation between the primary and secondary and also aids in keeping them at a low temperature.

There are many kinds of transformers now constructed for the market. The shape of one manufacturer's may vary from another, but the principles upon which they work and the ends that they attain are practically the same in all makes.

When the electrical current is to be sent great distances, the main line is usually of a very high voltage ranging nearly 2,300 volts and is run direct to the large transformers near the center of distribution which reduces the current to possibly 500 volts at the secondary, and then lines are run from here carrying this 500 volt current to small transformers placed upon poles near the houses, which again transforms the 500 volt current of the large transformer down to 110 volts , this being led into the house or factory for lighting and power purposes.

PNEUMATICS.

By C. C. MAISON,
Author of "Trigonometry Simplified."

PNEUMATICS is that branch of mechanics which treats of the mechanical properties of gases and the machines by which they are used.

The molecules of a gas has a repellant action upon one another, and the gas will expand indefinitely unless restrained. These molecules are supposed to be moving through space with great velocity in straight lines, hence any quantity, however small, will fill the vessel in which it is confined and will exert pressure upon the walls of the vessel. This force with which gases try to expand is its tension, and is illustrated by placing a very thin glass bulb filled with air under the receiver of an air pump. When the air in the receiver has been pumped out the pressure upon the outer surface of the bulb is greatly reduced, and the force exerted by the pressure of the gas confined within it is sufficient to shatter the walls of the bulb.

The earth is surrounded by air comprising the atmosphere to a depth variously estimated at from fifty to several hundred miles. Like all other forms of matter, air has weight. The fact may be shown by weighing a quantity of air. Take a hollow metal sphere and accurately determine its weight, exhaust the air from the sphere and when again weighed it will be found to be lighter than before, the difference being the weight of the air removed.

Archimedes' Principle applies to air as well as water, hence if a body weighs less than an equal volume of air, it will rise in the air. This principle is applied to balloons. A balloon will support a weight equal to the difference between the weight of the balloon, including the contained gas and the weight of displaced. Suppose a balloon ai weigh 2,000 pounds, the gas bag 50 feet in diameter and filled with gen. The volume of air displa about 65,480 cubic feet, and the of gas contained is about 65,450 feet. The weight of the air displ .0761x65,480=4983.03 pounds, ai weight of the hydrogen is .00528x =345.68 pounds. Then the total of the balloon is 2,000+345.58=2, pounds. The buoyant effect of th 4,983.03—2,345.58=2,637.45 pou

The pressure of the atmospl measured by the barometer. I shows an aneroid barometer whic sists of a vacuum chamber compo four corrugated metal discs from the air has been exhausted. Tl disc is force inward by an incre the pressure of the atmosphere forced outward when the press the atmosphere diminishes by me its own elasticity, aided by mean spring within. These movemen transmitted and multiplied by a of levers which also act upon an made to move over a graduated They are very delicate instrumen are used chiefly on account of their bility. They are useful in mea the heights of mountains, the di heights being marked on the dial t respond to the pressure.

Marviotte's Law says, "If the ter ture of a gas remain constant, the v will vary inversely as the pressur Fig. 2 we have what is called Marv tube, the end a, is sealed, while b is A small amount of mercury is p into the tube, inclined to admit t

r out as the case may be required, il the mercury stands at the zero k in each branch. The air in the rter branch has the same tension as

Fig. 1.

Fig. 2.

r columns and just balance each other mercury be poured into the tube b l the column in the short branch reaches c, the enclosed air occupies one-half its former volume, and the mercury in the long column will be about 30 inches above c. The air in the shorter tube is now under pressure of two atmosperes; one of mercury and one of air. If more mercury be poured in until the air occupies one-third its original volume, the height of the column in the long tube will be about 60 inches; that is, three atmospheres; two of mercury and one of air have reduced the air to one-third of its original volume. This law holds good up to about 30 atmospheres and is applicable when the pressure is diminished, as the volume increases in the same proportion as the pressure is decreased. If a tube nearly full of mercury is inverted over a mercury bath and lowered until the mercury in the tube and bath is the same, the pressure of the air in the tube is one atmosphere. Note the volume of air in the tube, raise the tube until the volume of air is doubled, then the difference between the heights of mercury in the tube and bath will be about 15 inches, or one-half the height of the barometric column. The air now occupies twice its original volume, but is subjected to a pressure of one-half an atmosphere, and therefore since the weight or amount of gas remains unchanged when subjected to pressure, its density varies directly as the pressure and inversely as the volume. For a given amount of gas a certain pressure, let p equal the pressure, v the volume and d the density, and for any other pressure let p' equal the pressure, v' the volume and d' the density. Then we have

$$p\ v = p'\ v'$$
$$p\ d' = p'\ d$$
$$v\ d = v'\ d'$$

and since gases vary inversely as its density, the weights may be substituted

an assistant. The draftsmen are not allowed in this vault, consequently when a tracing is wanted it can only be obtained through the keeper. Each draftsman is numbered numerically, and for each tracing he gets he gives a cheque which bears his number. In this manner the keeper at a moment's notice can locate where any tracing is in any squad without much bother and loss of time. parts of the globe, and at present there is under way structural steel and iron amounting to many million tons, both for foreign and local trade. At present there are employed in their Ohio shops (one in Akron known as the Webster, Camp & Lane division) over 600 men, exclusive of outside erectors and foremen on various jobs. The office building is made of red brick, four stories high, whose di-

These tracings are kept in dust-proof drawers which are alphabetically arranged, and put in the same numerically, regardless of size. Very rarely a mistake occurs, and when such is the case it is rectified in short time owing to the method used. This manufactory is one of the largest of its kind in the world. Machinery and structural appliances are manufactured in these works for all

mensions are 130x63'. The drafting room and engineer's office is located in the second floor, the former being 130'x 40'. It is illuminated by electricity and a north light. The other floors are divided in several other departments and are all managed and kept under the most modern principles. The company is represented in many large cities in the states as well as abroad, including London.

MACHINE SHOP ROOFS.

.Y, roofs are for the pur-
protecting buildings and
s from the elements, and
for machine shops are
rom roofs of other build-
the machine shop the
p to do many thing be-
le to do these things may
ification of the regulation
in some cases add to the
will more than justify the
Assume, for example, a
revailing type—a central
aveling cranes and wings
each side. The roof over
y has no function to per-
it well be made to serve
rpose except to ward off
and no question can arise
: usual form of construc-
and most economical?

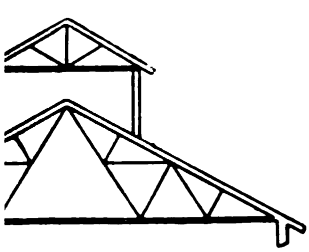


FIG. 1

d is used for purlines and
protection against the
is greatly improved, and
en purlines and rafters
Where this form of struc-
r a foundry, as is com-
question of ventilation or
truction presents itself,
which this is often treat-
k well. (See Fig. 1.) The
makes a roof that way
it it is simple, that it stands, and what more do you want? It is just in these points that the engineer lacks the training of the architect, who would do the job as shown in Fig. 2. which brings rigid points of support under the weight of the monitor and the length of the compression member is shorter. It looks right, and, like other things mechanical, when it looks right, it is pretty safe to conclude that it is right.

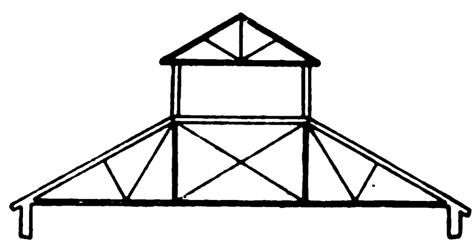


FIG. 2

About sixty years ago, more or less, one Emerson designed a form of stationary ventilator, that no matter in which direction the wind blew, air would be drawn up the vertical pipe. This is shown in Fig. 3. The same principle can be applied in foundry or other buildings where ventilation is required, as shown in Fig. 4.

In the section of shops where there are no traveling cranes, but line shafts, counters, pipes, etc., the trusses 8 or 10 feet beween centres offer special advantages. Line shafts not over 2 1-2 inches in size require supports and hangers as often as 8 feet, and 3-inch shafting as often as 10 feet, and there the frequent trusses supply a far better support than it is possible to get where trusses are 20 or 30 feet apart; and with the lower chords made as they should be, of two ell or channel irons,

Limit of Caulking Pitch in Boiler Work

to Secure a Steam Tight Joint.

PROF. PETER SCHWAMB, MASS. INST. OF TECHNOLOGY.

P=Test Pressure. $V_0 = \frac{\text{Load} \times L^2}{384\ E\ I}$ = Deflection.

THICKNESS OF PLATE. INCHES.	V_0=0.00035′			V_0=0.0003′.		
	P=120 lbs. per sq. in.	P=150 lbs. per sq. in.	P=225 lbs. per sq. in.	P=120 lbs. per sq. in	P=150 lbs. per sq. in.	P=225 lbs. per sq. in.
0.250	2.53	2.39	2.16	2.43	2.30	2.38
0.3125	2.99	2.83	2.55	2.88	2.72	2.46
0.375	3.43	3.24	2.93	3.30	3.12	2.82
0.4375	3.85	3.63	3.29	3.70	3.50	3.16
0.500	4.25	4.02	3.63	4.09	3.87	3.50

TIMBER MEASURE.

READY RECKONER.

SIZE IN INCHES	LENGTH IN FEET, OF JOISTS, SCANTLING, AND TIMBER.							
	12	14	16	18	20	22	24	26
2x 4	8	9	11	12	13	15	16	17
2x 6	12	14	16	18	20	22	24	26
2x 8	16	19	21	24	27	29	32	35
2x10	20	23	27	30	33	37	40	43
2x12	24	28	32	36	40	44	48	52
3x 4	12	14	16	18	20	22	24	26
3x 6	18	21	24	27	30	33	36	39
3x 8	24	28	32	36	40	44	48	52
3x10	30	35	40	45	50	55	60	65
3x12	36	42	48	54	60	66	72	78
4x 4	16	19	21	24	27	29	32	35
4x 6	24	28	32	36	40	44	48	52
4x 8	32	37	43	48	53	59	64	69
4x10	40	47	53	60	67	73	80	87
4x12	48	56	64	72	80	88	96	104
6x 6	36	42	48	54	60	66	72	78
6x 8	48	56	64	72	80	88	96	104
6x10	60	70	80	90	100	110	120	130
6x12	72	84	96	108	120	132	144	156
8x 8	64	75	85	96	107	117	128	139
8x10	80	93	107	120	133	147	160	173
8x12	96	112	128	144	160	176	192	208
10x10	100	117	133	150	167	183	200	217
10x12	120	140	160	180	200	220	240	260
12x12	144	168	192	216	240	264	288	312
12x14	168	196	224	252	280	308	336	364
14x14	196	229	261	294	327	359	392	425

Table of Safe Load on Binding Wires.

Factor of Safety 10.

Brown & Sharpe Gauge.	TINNED STEEL WIRE Ult. Ten. Str. 150,000 lbs. per sq. in.	PHOSPHOR BR. WIRE. Ult. Ten. Str. 100,000 lbs. per sq. in.
6	309	206
7	245	163
8	194	130
9	154	103
10	122	82
11	97	65
12	77	51
13	61	41
14	48	32
15	38	26
16	30	20
17	24	16
18	19	13
19	15	10
20	12	8
21	9	6
22	7½	5
23	6	4

WROUGHT AND CAST IRON BEAMS.

By St. Ann's.

PART I.

incipal materials used in engi-
ıg constructions are timber,
e, cast iron, wrought iron and
ıe specific gravities are:

	AV. WEIGHT. Lbs. per cu. ft.	AV. WEIGHT. Kil. per cu. meter	Average Specific Gravity.
.. ..	40	600	0.6
.. ..	125	2,000	2.0
.. ..	100	2,560	2.6
.. ..	450	7,200	7.2
iron	480	7,700	7.7
.. ..	490	7,800	7.8

reights considered to be the
rerage values. Take wrought
example, when it is necessary
e the weight for I beams,
pieces of uniform cross sec-
know a wrought iron bar
n section and one yard long
n pounds. A wrought iron
3" and 12 feet long; its cross
4.5 square inches, hence its
4 5×4=180 pounds, while a
of the same dimensions will
180+0.02×180=about 184
ıd a cast iron bar will weigh
×180=about 169 pounds.

cross section of bars can be
nputed from their weights per
ıs if a stick of timber 15 feet
ıs 120 pounds. its weight per
pounds, and its cross section
= about 28.8 square inches.

: How many square inches
ss section of a wrought iron
ng 24 pounds per lineal foot?
eams are to be designed the
which it is to be subjected are
known, as also the length and its maximum bending movement may be found from the formula

$$\frac{I}{C} = \frac{M}{S}$$

As example, we take a cantilever beam whose length is six feet, breadth 2 inches, depth 3 inches, and which is loaded uniformly with w pounds per linear foot. To find the value of w so that S may be 800 pounds per square inch.

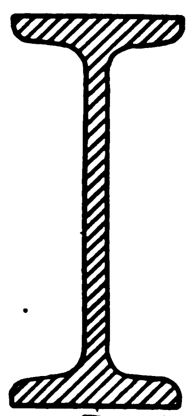


FIG. 1.

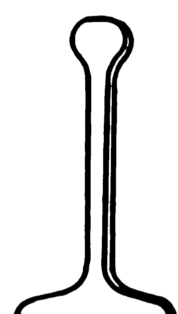


FIG. 2.

C=1½ inches; I=$\frac{54}{12}$×M=56×6W.

$$\text{Then from } 216W = \frac{800 \times 54}{1\tfrac{1}{2} \times 12} = 11 \text{ pouuds.}$$

but a wooden beam 2×3 weighs 2 pounds per linear foot, therefore the safe load would be, say 9 pounds.

Wrought iron I beams are rolled in probably fourteen different depths or sizes; of each is a light and a heavy weight, and weights intermediate in value may also be obtained. They are extensively used in engineering and architecture. The sizes of different manufacturers agree as to depth, but vary slightly with regard to proportions of cross section, weights per foot and mo-

ments of interia. In the following table the cross section is obtained from its weight per foot by multiplying by 3 and dividing by 10, in accordance with rule already given:

Size. Depth Inches.	Wdth of Fl In.	Wt. per ft.lbs	I In. 4	I/C In. 3	I' In. 4
Heavy . . 15	5.81	80	750	100	29.9
Light . . . 15	5.55	67	677	90.3	25.4
H 15	5.33	65	614	81.9	20.0
L 15	5.03	50	530	70.6	16.3
H 12	5.09	60	340	56.7	15.5
L. 12	4.64	42	275	45.9	11.0
H 10½	4.92	45	201	38.3	10.7
L 10½	4.54	31½	165	31.4	8.01
H 10	4.77	45	187	37.5	11.3
L 10	4.32	30	150	30.0	7.94
H 9	4.33	33	117	26.0	7.14
L 9	4.01	23½	97.5	21.7	5.48
H 8	4.29	35	90.4	22.6	6.96

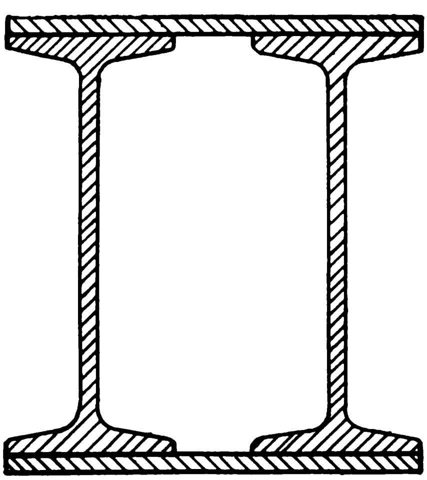


FIG. 3.

In finding the strength of a given I beam the value of $\frac{I}{C}$ is taken from the table and I is computed from the formula

$$S = \frac{36000 \times 12 \times 6}{338} = 7700 \text{ lbs. per}$$

square inch, or for example let it be required to determine which I should be selected for a floor loaded with 150 pounds per square foot, the beams to be of 20 feet span and spaced 12 feet apart between centers, and the maximum unit stress S to be 12,000 pounds per square inch. Here the uniform load on the beam is $12 \times 20 \times 150 = 36{,}000$ pounds= W.

$$\frac{I}{C} = \frac{M}{S} = \frac{36000 \times 20 \times 12}{8 \times 12000} = 90.$$

Turning to the tables we find that the light 15 inch I beam is required. The factor of safety for a body under stress is the ratio of its ultimate strength to the actual existing unit stress. The factor of safety for a piece to be designed is the ratio of the ultimate strength to the proper allowable working strength. Thus if s t be the ultimate, S the working strength and f the factor of safety, then $f = \frac{st}{s}$ and $st = fs$. Thus we see that the factor of safety is always an ab-

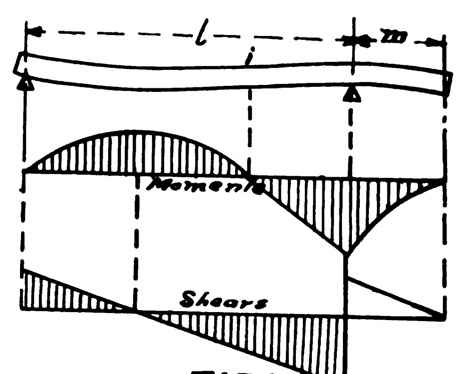


FIG.4.

stract number, which indicates the number of times the working stress may be multiplied before the rupture of the body. The dimensions to be chosen for the beam must give a value of $\frac{I}{C}$ equal to this numerical value, and these in general are determined tentatively, certain proportions being first assumed, but the selection and proper proportions and shapes of beams for different cases re-

:s much judgment and experience. . 1 and 2 are forms of beams. For nce, a wrought iron beam of 4 feet is required to carry a rolling load ₩ pounds. Here by value of maxi- ı M due to the load of 500 pounds ɔoo pound inches, and the value for ıble load S is about 10,000 pounds square inch. Then

$$\frac{1}{c} = \frac{60000}{10000} = 0.6 \text{ inches.}$$

nfinite number of cross sections may elected with this value $\frac{I}{c}$. If the ı is to be round and of diameter I, known that $c = \frac{1}{2}$ d and $I = \frac{\pi d}{64}$

ence, $\frac{\pi d^3}{32} = 0.6$, whence $d = 1.83$ inches.

PART II.

column is a prism, greater in length about ten times its least diameter, h is subject to compression. If the n be only about four or six times as as its least diameter the case is one mple compression, the constants for h are given in Part I. In a case of le compression failure occurs by the hing and splintering of the material, y shearing in directions oblique to length. In the case of a column, ever, failure is apt to occur by a wise bending, which induces trans- e stresses and causes the material to ighly strained under the combined pression and flexure. In designing lumn it is hence advisable that the cross section should be so arranged that the moments of inertia about the two principal rectangular axes may be ap- proximately equal.

Take, for instance, it is required to con- struct a column with two I shapes and two plates, as shown in Fig. 3. The I beams are to be light 10 inch ones, weigh- ing 30 pounds per linear foot, and hav- ing the flanges 4.32 inch wide. The plates are to be one-half inch thick, and it is required to find their length x so that the liability to bending about the two axes shown in Fig. 3.

A cantilever beam has its upper fibres in tension and the lower in compression, while a simple beam has its upper fibres in compression and the lower in tension. Evidently a beam overhanging one sup- port, as in Fig. 4, has its overhanging part in condition of a cantilever, and the part near the other end in the condition of a simple beam. Therefore there must be a point i where stresses change from tension to compression, and where the curvature changes from positive to nega- tive. This point is called the inflection point; it is the point where the bending moment is zero. Since the beam has but two supports, its reactions may be found by using the principle of mo- ments. Thus in figure 4, if the distance between the supports be l, the length of the overhanging part be m, and the uni- form load per linear foot be w, the two reactions are

$$R^1 = \frac{W l}{2} - \frac{W m^2}{2 l} \text{ or } R^2 = \frac{W l}{2} + W m + \frac{W m^2}{2 l}$$

whose sum is equal to the total load w $l \times w$ m.

CURRENT TOPICS.

IN last month's issue of The Draftsman we announced a new magazine, "The Hoister and Conveyor," but it has been decided to consolidate that one and The Draftsman under the name of "Brownings' Industrial Magazine." The new arrangement will give a larger and better magazine, of which this is a sample as to make-up and size. It will be our aim to build up the character of the reading pages and to supply data of value to contractors, engineers, designers and draftsmen.

Mr. Chester A. Cathcart, draftsman for the Elektron Mfg. Co. of Springfield, Mass., has taken a position in the drafting room at the Waltham Mfg. Co., of Waltham, Mass.

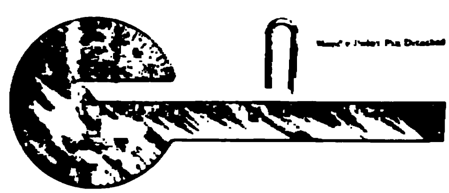
Mr. Boynton, who has been writing the articles on tool drafting, will be unable to add more to the series at present, for his work is requiring much more of his time, yet he may be able to send us an article occasionally.

We regret that due to the oversight of the printers who do our press work the data sheets were omitted from some of our December issue. Drop us a postal if you want one. There are two tables, one on Heavy Hand Wheels and the other on Concrete Tests. This month we have a fine table by Mr. E. J. Lees, of hand wheels for machine tools.

It is with deepest regret that the announcement is made of the death of Mr. Dan Wehnes, draftsman at the Cleveland Armature Works, shortly before Christmas. Mr. Wehnes was a student at the night school of Central Institute for several years, and his work reminded one of a growing flower, as it budded and grew and blossomed into a broader and clearer knowledge of the studies in hand. Why should such promising men be taken when there are so many old hulks afloat?

Almorth's Protractor.

The usefulness of this protractor will be readily appreciated by observing how quickly and accurately it may be adjusted to any desired angle. The fact that the instrument is so marked that it may be read or set from both sides, gives it a decided advantage over the ordinary half-circle protractor. Another entirely unique feature, and one that means the saving of much time in many operations, is that by which any radial line, up to four and one-half inches in length, may be drawn without removing the instrument.



Insert the needle point at the apex of the angle or center of the circle to be graduated. Turn instrument until the desired degree reads from the given line. Angles of greater than 90° may be obtained by addition as 120°=90°+30°, etc., etc.

It will be noticed the center edge of graduated arm is cut away to allow for width of pencil point.

The needle point may be easily removed by spreading slightly.

The protractors are made of spring metal and the methods of manufacture such that absolute accuracy and satisfaction are guaranteed or money refunded.

Price, 50c.; with leather case, 65c.

G. A. Almorth, Needham, Mass.

CORRESPONDENCE.

On Organization.

Fort Worth, Texas.

"The Draftsman," Cleveland, O.:

r Sir—I have been reading with a deal of interest the articles which ave been publishing in late issues r magazine, relating to the organi- of a draftsman's society.

"Beam Compass" has, in the No- r issue of "The Draftsman," pre- several excellent views on the sub- ll of which I heartily endorse. Es- y do I favor the position he has in opposing the incorporation of unionism idea which a writer a or two since associated with the of the proposed organization.

fact that labor unions have, in st, been of benefit to members in instances cannot be denied, but I sitive that a labor union would be ental to the educational purposes hich, alone, this society should be zed, since unionism is defensive than educational.

abor organization does not afford embers the technical instruction, it which the drafting world cannot to rise to its rank as a profession. roposed society should especially te literature, hold conventions and age independent thinking and dis- ution of new ideas, and the stronger ature of the society is made, the progressive will be the members f. A draftsman forms his own early, but the ideas of other drafts- are valuable, for there is always ing that is valuable in our pro- that we can learn from others.

uld the society be organized as a al one, all members would be together in mutual friendship, as if in a union, but in a far more nt and beneficial way.

m this it is seen that the only advantage in a union over an educational society might possibly be in the question of wages, but when we probe this to the bottom we find that even this gives way to thin air, for the simple reason that draftsmen are rated according to their ability. Nowhere is a person going to be compelled to work as a tracer or detail man, with the wages of such, if he is competent to do designing. The profession is not, and never will be, so crowded as to cause such a state of affairs to obtain.

To the draftsman who thinks he is being overworked, I would suggest the saying of C. A. Pillsbury, who remarks, "Young men can best earn promotion by working overtime, if need be, to serve their employers' interests. There are vacant places in the higher walks of every business and profession for those who follow this course."

Hoping to soon hear of the society's organization being completed, I am, yours truly, E. RASER.

How One Society Was Started.

To the Editor of "The Draftsman:"

Dear Sir—Some of us at the Knox Automobile Co. have held frequent "short sessions," at which we have discussed the advisibility of organizing the local draftsmen into a society or association, believing that it would be a source of mutual help both socially and technically.

We compared notes and found that there were about fifty "pen-pushers" of whose addresses we were sure, and so we had some short circular letters typewritten and mailed one to every man that we thought might be interested.

Here is a copy of our "opening wedge:"

Springfield, Mass., Nov. 7th, 1905.

Dear Sirs—Realizing the need of and the help gained from an exchange of

thought upon mechanical problems of tried formulae and tables and for the betterment of the profession as a whole, we wish to ascertain the views held by the draftsmen of Springfield on the formation of a society of draftsmen both mechanical and architectural.

If you are interested and would join such a society, will you kindly state your views on the subject?

Yours very truly,
Draftsmen of the Knox Automobile Co.

We received twenty five answers, of which twenty were in favor of joining such a society, four thought it would be "a good thing for the other fellow," but "had no time to give to it personally," and one man held the opinion that mechanical and architectural draftsmen never could be united and cited the fact that just because we all used the same tools that did not make us of kindred minds.

We concluded that the sentiment of [illegible] was in favor of carrying [illegible] further, and so the [illegible] was sent out [illegible] we are anxious [illegible]

[illegible]

request is extended to you to be present, by the Committee on Organization.

Yours very truly,
W. F. FRONCK,
F. P. BARKER,
H. W. GIFFIN,
Committee.

P. S.—Please call the attention of all draftsmen of your acquaintance to this matter.

(*More to come next month.*)

Membership of Society.

I read with some displeasure the article in the December number by Mr. Lincolnite, in which he refers to Article II, Section 1 of the constitution and laws proposed by me for our organization of draftsmen, of which he takes exceptions to its membership qualificaations, i. e., that all applicants must be *white* male American-born or naturalized citizens.

He states that this is an era of enlightenment and possibilities; and "I may add personality and opportunity," and asks why should not a colored man be a member of the league, saying that he has worked with colored draftsmen and found them very applicable, and there should be no reason "in his judgment" why they should not be allowed to join such an association. Now does Mr [illegible] forget that his employer is [illegible] which he ("Lincolnite") was [illegible] to affiliate with those enterprising colored gentlemen? and rather [illegible] his position he submits; or [illegible] impress the idea upon [illegible] fraternity that he makes [illegible] distinction of his as- [illegible]

[illegible] Lincolnite's political pre- [illegible] is quite absurd, for [illegible] that the Emancipa- [illegible] the colored man [illegible] and a right to [illegible] any other law requires

the white man must recognize the red man in society. There are many rate orders, clubs, public schools, ches, railroad and trolley cars, etc., give evidence to substantiate this and there is no reason now why the ligence of the white draftsman of rica should be mingled with the colman, for his degradation has been nounced ever since the curse of aan.

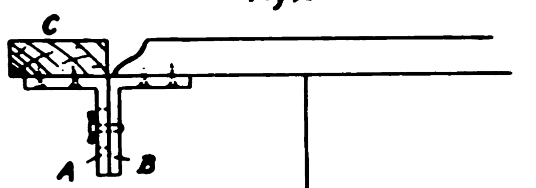
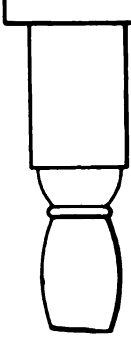
E. B. HAYES.

A Handy Drafting Table.

he accompanying sketch shows a venient device for converting any mon table into a good and serviceable

Fig 1

Fig 2

drafting table. Fig. 1 shows a side v of this device and Fig. 2 an end v attached to the table. The bracket s slotted, while the bracket B is taped a thumb screw by which the straight e C can be adjusted for any variations t might occur between the thickness the table and the thickness of the ight edge. As seen in the sketch, it ecured to the table merely by a few d screws, and in this manner it can attached or detached very readily.

F. P. WEIZENEGGER,
'au Claire, Wis.

Question Box.

A question box will be opened in our next issue. Send in your questions.

In the last issue of The Draftsman in the article on Hydrostatics, Fig. 1 should have been in place of Fig. 2.

What's in a Name?

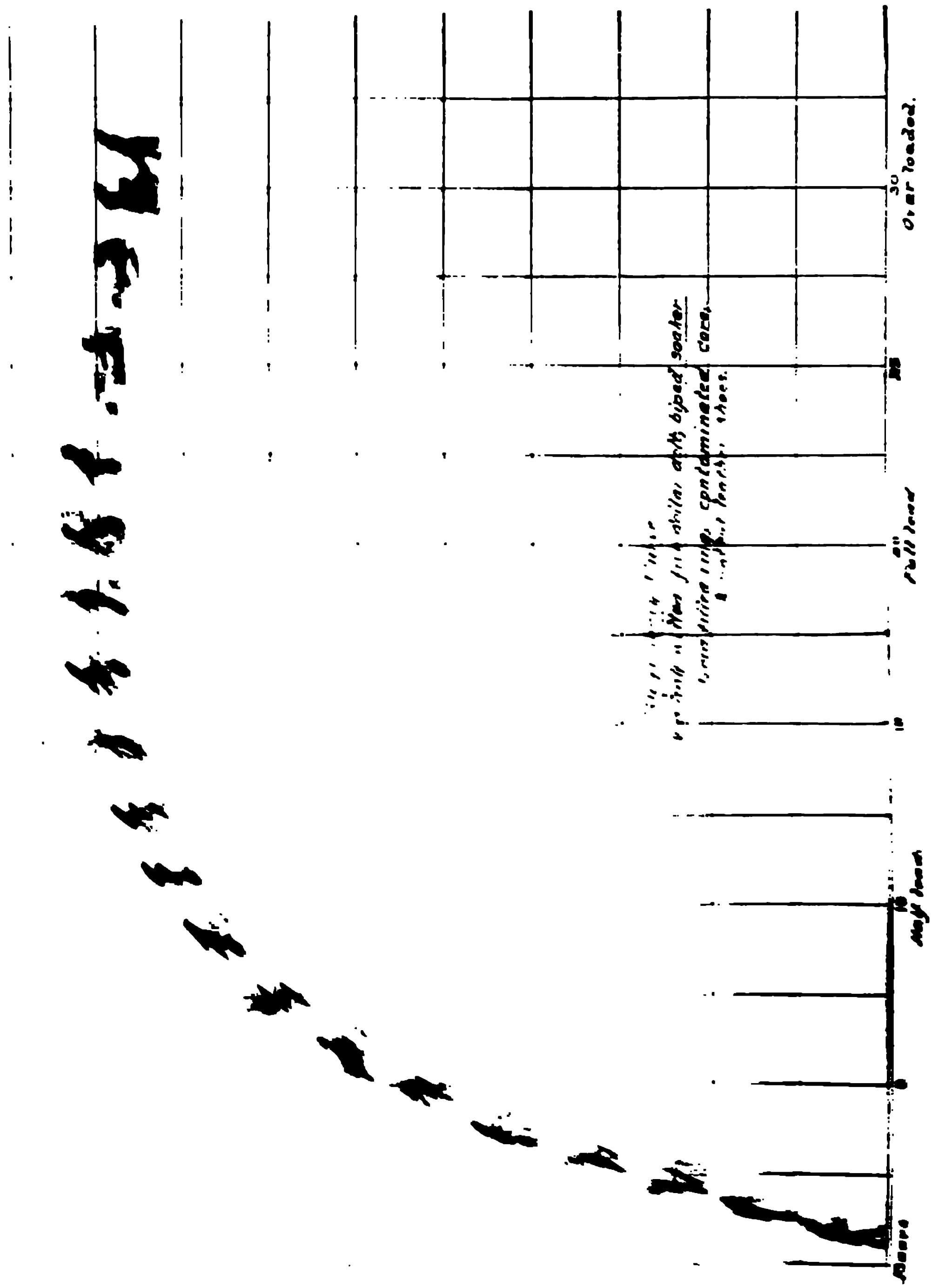
The monthly, The Pattern Maker, formerly published by the Penton Publishing Co., but now owned by the Gardner Publishing Co., has been changed and enlarged and is now under the title of Wood Craft.

It is the aim to publish a magazine for all wood workers, but giving considerable space to pattern making.

An eastern editor remarks: "In selecting a name for their paper the publishers adopted a very misleading one, as wood craft is skill in hunting; in fact there was a quarterly sporting paper published in New York with the same title."

It may be a hunting paper—hunting for subscribers and advertisers.

We publish on this page an unique [illegible] by [illegible] H. Bickell, chief [illegible] of the [illegible] Co., [illegible] Mass. Although it appeared in the Engineering Journal of Canada it may be of interest to many of our readers who are working on diagrams of various kinds.



BROWNING'S INDUSTRIAL MAGAZINE.

VOL. V FEBRUARY, 1906. NO. 2

Electric vs. Steam Driven Locomotive Cranes.

By Frank C. Perkins.

TO decide definitely in favor of the electric locomotive crane or the steam locomotive crane for contracting work, railway work, or even yard service of large manufacturing plants is extremely difficult even where electric power is available, as there are many circumstances which make the one more desirable than the other. For instance, in case it is found necessary to utilize the crane at a considerable distance from the source of electric power and away from the conducting trolley wires or third rail which supplies the current, an electric crane would be useless, while the steam driven locomotive crane having its power self contained could be utilized at any point desired.

On the other hand, where a number of cranes are desired for continual operation,

Fig. 1.—German electric locomotive jib crane.

Fig. 3.—Three ton steam locomotive crane, 12' variable radius boom, standard gauge track.

Fig. 4.—Ten ton locomotive crane, showing bucket removed and bottom block substituted.

from one trolley wire, passed through the electric motor and controlling apparatus and returned through the other trolley pole and overhead conductor.

The three ton steam locomotive crane, having a twelve-foot variable radius boom with a truck operating on a standard gauge track, as noted in the accompanying illustration, Fig. 3, as well as the variable radius attachment, as well as counterweight boxes, track clamps and drawbar attachment. It has a total weight, without counterweight, of 58,000 lbs.

The steam, as well as the electric, jib cranes are utilized in England as well as in America, both types having their adherents among well known engineers. One of the accompanying illustrations

[illegible]

[illegible]

[illegible] Colombo [illegible] Bath, England, [illegible] while another [illegible] locomotive crane [illegible] installed at the [illegible] Wales by [illegible] Lancashire, England.

[illegible] has also

been recently constructed a 6-ton and a 12-ton electric derrick crane with a 60-foot jib, which has resulted in an increased economy, as there is no waiting until steam is raised, for simply by turning the switch the maximum power is at once available, and as soon as the work is done the current can be at once shut off, so that no power is wasted, even if the crane is at times only wanted for occasional lifts. The use of electric cranes of the locomotive type, fixed derrick type,

Fig. 6.

or overhead travelling type, is, of course, dependent on a central power station as a source of supply, and if current is available continuously on account of its use elsewhere for operating motors, in machine shops, electric lights and various electric driven machine tools, the electric crane can be utilized economically and to great advantage. It certainly has the advantage of the steam crane and in that there is an entire absence of smoke and dirt, which is inseparable from the use of a steam crane, while the driver's attention may be always on his work with the electric crane, there being no necessity for firing up and attending to faulty pumps and injectors. Another German five-ton electric locomotive crane is shown in an accompanying illustration, Fig. 7, as built by the Gesellschaft fur Elektrische Industrie of Carlsruhe I. B. Germany, the motor used in this crane being of three-phase alternating current type, its locating being shown just inside the cab.

Fig. 7.—German five ton electric locomotive crane built by the Gesellschaft fuer Elektrische of Karlsruhe, Germany.

ELEMENTS OF CRANE CONSTRUCTION.

By C. Chas. Maison, Author of "Trigonomety Simplified."

IN no structures built by engineers is the question of due relation of strength to stress of greater importance than in cranes. Yet in few does more empiricism exist, in few is the accumulated experience of success and failure of greater value—a case which has notable parallels in the history of the development of the locomotive crane, and of machine tools, neither of which are much indebted to theory. There are certain crane elements

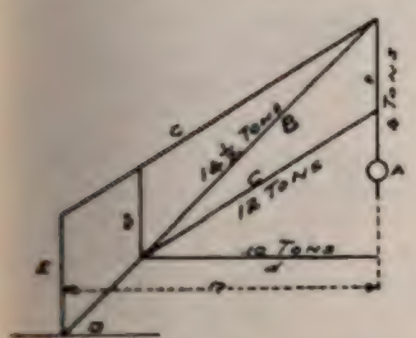


FIG. 1.

in regard to the strength of which calculations are of much value, because the stresses are readily obtainable by the methods of graphic statics. These are the elements of which the cranes are built, and the strains on chains, hooks and snatch blocks. But the main side frame castings, and the plated frame castings, are not readily calculated, and, in fact, are almost invariably copied or modified from previous designs that have stood successful service. In the drawing room of crane shops new designs are got out without much direct calculation, because previous practice is drawn upon. The more highly the work of a firm is specialized, the more easily can modified designs be produced. There are tables kept in the office, giving loads for various sizes of chains, wire rope, and the strength of the different standard hooks used, the strength of rods of various cross sections, and a deal more of the same character, by which direct, often repeated calculations are rendered unnecessary. Then there are certain points of gears and drums which have been previously used, and these can be taken en bloc, and put on other cranes that vary

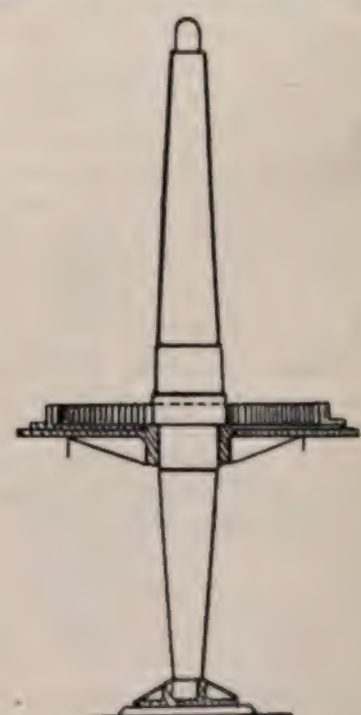


FIG. 2.

in details of design. Jibs are standardized for different radii and power, and these need not be recalculated. So are trucks, posts, ground wheels; and then, too, there are standard superstructures that can be taken bodily and put on either portable or fixed bases. The reason

why calculations are so greatly modified is that though stresses can be obtained for certain elements with absolute precision, and in others with a fair approximation thereto.

In the writer's experience there is no single section of a crane which has not been overworked, whether checks, posts, jibs, chains, the rods, trucks, both cast and plated, traveller girders, tooth wheels, and drums. Accidents occur because the machine is called upon to perform work which it was not designed to do, and very often the cause is the reliance placed in past actions, which a certain crane did over or nearly a half century ago. There are few machines, speaking indiscriminately, that are more ill used than these.

The checks of cranes are subject to great variations in design. In small cranes they are of cast iron; in heavy ones, steel plated. But many small cranes are cheaply made with steel plate, while for permanent way cranes this type is always employed. Plated work is today thirty per cent cheaper than formerly, and is by far more reliable than castings. But castings cost still less, because the bearings are in one with the frame, while in plated work the bearings must be prepared separately and bolted or riveted on. But these are often cheaply fitted in the form of round bosses in place of the more

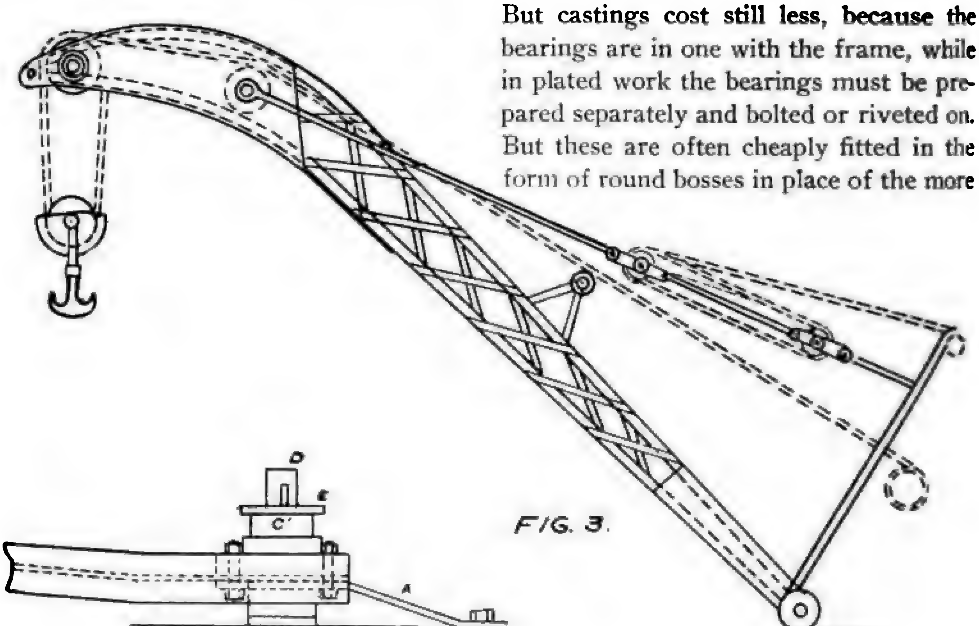


FIG. 3.

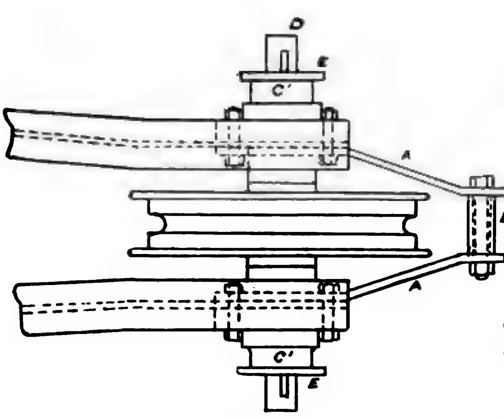


FIG. 4.

expensive divided bearings, according to the purchaser, of course.

In the simplest types of the true cranes the elementary frame is a triangle, composed of post, jib and tie. It is embodied both in pieced and in portable cranes, of the wharf, whip, wall, derrick and many other types, and includes cranes in which jibs are curved, or cranked to clear loads beneath. The relative disposition of the three members governs their relative strength, and these dispositions are controlled by the nature of the [illegible] ch
cranes have to pe
and directior

gular frame, as shown in Fig. 1. he most common type, called the ib type arrangement. The dia- only correct when the load to be a single chain and the line of om the head pulley to the drum, with the centre of the tie. This used for variable radius. The uns over a fixed pulley, at the e jib B, the radius R of which rable, except by derricking. No or jinney can run along this vary the radius of the load lifted; e reason why many of these are derrick. That is, the jib is t D in order to permit of effect- ations in the radius of lift, ac- ed both in the derrick cranes nd in many ordinary cranes that om the true derricks in most de- cepting in the capacity for this r range of movement.

ost, pillar or mast, as it may be is a vital element in all triangular ranes, with those few exceptions a wall depends on fulfilling the The stability of a crane de- the first place on that of the post. ils it will do so either by break- t or near the ground line, where imum bending stress occurs in hat are supported in a footstep cranes that have top pivots in the post would fail somewhere the top and bottom pivots—a de- g factor in which would be the where the jib happens to be into the post. From this point the nearer the jib is brought the ground line, the better, having regard to the racking of wards, this is the least favorable Posts are made of timber, cast steel, sometimes wrought iron idly or built up like girder work. a solid post built up of steel as used in wharf or warehouse. Jibs, struts and ties are grouped together because they are mu- tually dependent. A jib with a few ex- ceptions is not self-supporting, but is sus- tained by ties or with struts. From this point of view various forms of jibs be- come grouped naturally under three broad types—the cantilever, strut sup- ported, and the tie supported. The first are not numerous, the second only mod- erately so; the greater number of ex- amples come under the last named head. Cantilever jibs are used chiefly on some forms of long-armed cranes, usually of the travelling type, with or without pro- vision for rotation, as on the Brown cranes and related types. Having no ex- traneous support they are built of girders of semi-parabolic outlines.

Under travelling cranes there is in- cluded all those which come under the class of overland travellers of Goliaths and gantries. The term is applied ex- clusively to these, notwithstanding that the portable cranes with trucks travel on rails. But the term portable, or the term locomotive, also applied to these, dis- tinguishes them from the travelling cranes. The distinction is purely con- ventional, but is always understood. There are a number of designs, as those which exist in the frames of travelling cranes, and are too numerous to make mention of all of them.

Fig. 3 shows a cranked jib which is laced, and is of a composite type in which the fitting of the rods at some distance away from the end leaves the portion be- tween the anchorage and the foot in com- pression, while the length beyond the anchorage is subject to bending as a cantilever. This jib is widened at the dividing section to afford strength to the cantilever end.

In Fig. 4 shows a simple jib head fitting for a chain pulley. Two pieces of steel plate AA are bolted between the H sec-

tions, and cranked to receive a distance piece B, which also prevents the chain from jumping outside the pulley pin D. The castings are prolonged into bosses C, over which the tie rod eyes fit, and on which they are retained sideways with washers EE. In many cases, also, are castings fitted instead of steel plates.

As over the stresses must be translated through truss rods; timber of reasonable depth alone being sufficient. The method of trussing, moreover, affects the result. A truss may be simple, see Fig. 5. Then the weight of the girders themselves, and of the crab and its load, and its position, has to be considered. The length, also, of the wheel base D affects the stresses on the end cradles C. Stresses on the wheels and their journals are calculated, as indicated in Fig. 6. Each wheel is taken as loaded with half the load of the main girders, and is wholly in compression. The stress on wheels, due to cross working of the frames, sometimes causes their axles to grind hard in their bearings. This may be eliminated by making the axles fast in their bearings and letting the wheels run loosely on them. The employment of iron and steel for travellers' frames affords scope for a large variety in design and dimensions. They are suitable alike for travellers, the power of which ranges from half ton to a hundred tons or more. Iron is, however, as already remarked, little used now, being mostly displaced by steel.

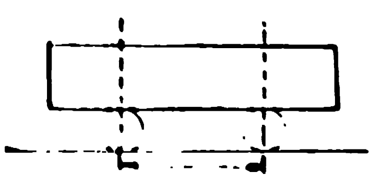


FIG. 5.

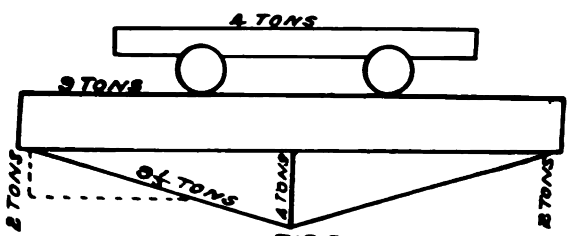


FIG. 6.

In use it might be supposed that overmuch attention has been given to the co-relation of material to stresses: it is well to point out that the question is less one of cost than of weight. It costs more to build up girders than to use rolled joists. It would generally cost more than the value of the metal saved. But that is hardly the point at issue. The dominating fact is, the reduction in the dead weight of the travelling crane. By lessening this the stresses on the travelling wheels and axles are lessened, and less power is required for operating—a point of much importance with high speed travellers, which are now so common.

Girders are not quite so simple a matter as this. In designing there are two points which have to be settled—rigidity depth-wise, that is, as opposed to buckling or crumpling, and rigidity side-ways, to assist the lateral stresses, which are produced by the rigid longitudinal movement of the crane.

EFFICIENCY AND STRENGTH OF GEARS.

By "Jamaica."

LTHOUGH much has been said and written both in books and gazines, yet little has been done to ermine the efficiency of the teeth of ring in the transmission of power, in consequence of which little of a nite nature can be said in this brief. he question being a practical one tly, it, therefore should be one where clusion is brought about by merely erimental rather than by analysis.

here have been experiments upon friction of spur gear tooth, and those of Sellers. From one of them it is wn that a gear of twelve teeth, two h, working in a gear of thirty-nine h, has an efficiency varying from nine- er centum at a slow speed to ninety per centum at a high speed. That an average of five per centum of the er received is wasted by friction at teeth and shaft bearings. This re- is probably a close approximation hat for any practical case. As said tofore, that theory can do nothing lecide such a question as this, but it do much to indicate probable results. uch a case the writer is merely mak- practical suggestions, which are per- already known, and in all proba- y can be found in many text books gears. If a pair of involute teeth, example, move over a certain space, either way from the pitch point, the ance being measured on the pitch , they will do work that is theoreti- y determined by this formula:

$$\text{ork done} = \frac{f\,P}{2}\;\frac{K \pm h}{K\,h}\;W^2$$

hich F is the co-efficient of friction, P=the pressure and K and h are the pitch radii of the gears. The positive sign is to be used for gears in external, and the negative sign for those in internal contact. The loss by friction, as shown by the formula, decreases directly as the diameters increase, the proportion of the diameters being constant. The loss increases rapidly with the distance of the point of action from the pitch point. When the contact is at the pitch point the teeth do not slide on each other and there is no loss, but away from that point the loss is as the square of the distance in this case, and is a still greater proportion in the case of the cycloidal tooth. Therefore a short arc of action tends to improve the efficiency.

It has been satisfactorily determined that the loss is greater during the receding action. This is not shown by the formula, but it may be laid to a variation in the co-efficient f. The formula shows that the loss is independent of the width of face of the gear, and therefore strength can be increased by widening the face without increasing the friction. If the work of internal gearing is compared with that of external gearing of the same sizes, the losses are in the proportion:

$$\frac{K-h}{K+h}$$

so that the internal gear is much the more economical, particularly when the gear and pinion are nearly of the same size. If the gear is twice the size of the pinion the loss is but one-third of the loss when both gears are external. Small improvement can be effected by putting

a small pinion inside rather than outside of a large gear. A six inch pinion working with a six *foot* gear has but 1.18 times the loss by the same gears when the gear is internal.

There have been many theoretical discussions in many periods by the American Society of Mechanical Engineers. The strength of a tooth is the still load it will carry suspended from its point, and it is to be carefully studied and distinguished form the horse power, or the load the gear will stand while in motion. The strength of a substance is not a fixed limit, but will vary with different samples, and with the same samples under entirely different treatment; allowance must be made for the quantity and quality of service the sample has done, while concealed defects are provided against, nothing but an actual test can give definite determination of its character.

It is approximated that a standard cast iron tooth, having an addendum about equal to a third of the circular pitch will average about three thousand five hundred pounds multiplied by the face of the gear and again by the circular pitch (both in inches) is equal the ultimate or breaking strength. But a tooth should never be forced up to its ultimate strength, and the best practice is to give it only about one-tenth of the load it might possibly bear, so that the following rule should be used: Multiply three hundred and fifty pounds by the face of the gear, and again by the circular pitch both in inches, and the product will be the safe working load of one tooth.

Example: A cast iron gear of one inch pitch and two inches face, will safely lift 350 × 2 × 1 = 700 pounds, although it would probably (not overestimating) carry 7,000 pounds.

When there are two teeth always in working contact it is safe to allow double the load, but care must be taken that both teeth are always in full contact.

A hardwood mortised cog has about one-third of the strength of a cast iron tooth; steel has approximately double the strength; wrought iron is not quite as strong. Small pinions as a rule generally have teeth that are weak at the roots, and then it will increase the strength to shroud the gear up to its pitch line, but shrouding will not strengthen a tooth that spreads toward the base, like an involute tooth, and when the face of the gear is wide compared with the length of the tooth the shroud is of little assistance. It does not increase the strength of a tooth to double its pitch, for when the pitch is increased the length is also increased, and the strength is still in direct proportion to the circular pitch, while the increase has reduced the number of teeth in contact at a time.

Cut gears and cast gears are about equal as to actual strength, with the advantage in favor of the cut gear, that hidden defects are likely to be discovered, and that it is not as liable to undue strains on account of defective shape. The rules for strength must not be used for gears running at any considerable speed, for they are intended only for slow service, as in cranes, heavy elevators, power punches, etc., etc.

The horse power of a gear is the amount of power it may be depended upon to carry in continual service. It is very well settled that continual strains and impact will change the nature of the metal, rendering it more brittle, so that a tooth that is perfectly reliable when new may be worthless when it has seen years in service. This cause of detoriation is particularly potent in the case of rough cast teeth, for they can only approximate an [illegible] be required to

a uniform speed, and the contin-
ct from shock and rapid varia-
he power carried must and does
e strength of the metal. There
as many rules for computing the
a gear as there are manufactur-
ears, each foundryman having
e only good one, which he finds
book treating on the subject in
ay fashion, and then he goes
uring the power down to so
ses and fraction and thinks he is
t as counting the number of
weight of casting. But this so-
actical method exists among
dard writers on engineering
and the agreement is no bet-
hown by Cooper and other
s. See the Franklin Institute
for July, 1879-80, which shows
ion of twenty-four rules from
fferent writers applied to the
se of a five-foot gear, and then
nty different results were ob-
ranging from 46 to 300
er, and proving conclusively
exact object sought is not to be
by calculation. This variety
nvenient, for it is always pos-
fit a desired power to a given
if a badly designed gear should
s a simple matter to find a rule to
at it was just right and must
some accident.

gh no rule can be called reli-
one that appears most to be the
at given by Box, also Beales, in
tises on small gearing. Box's
ch is based on many actual cases,
h gives among the lowest and
the safest results, is by the

$$\text{power of cast gears} = \frac{12c^2f\sqrt{dn}}{1000}$$

c = circular pitch, }
f = the face, } in inches
d = diameter, }

n = number of revolutions per minute.

Example: A gear of two feet diameter, four inches face, two inches pitch, running at 150 revolutions per minute, will transmit

$$\frac{12 \times 2 \times 2 \times 4 \times \sqrt{24 \times 150}}{1000} = 11.6 \text{ h.p.}$$

For level gears, take the diameter and pitch at the middle of the face. It is perfectly allowable, although it is not good practice to depend upon the gear for from three to seven times the calculated power, if it is new, well made and has no varying conditions, such as sudden shock as those subjected to in automobiles.

The influence of impact and continued service will be appreciated when it is considered that the gear in the example which will carry 11.6 horse power if impact is ignored, and the ultimate strength of the metal is the only dependence.

A mortice gear with wooden cogs will carry as much as or more than a rough cast iron gear will carry, although its strength is much inferior. The elasticity of the wood allows it to spring and stand a shock that would wreck a more brittle tooth of much greater strength, and for the same reason a gear will last longer in a yielding wooden frame than it will in a frame that does not permit of yielding. We know little and have to guess at it (as it were) the horse power of cast gears and very much so in respect to cut gears, as we are not so fully posted, as there never was any experimental data upon which a reliable rule can be founded.

Admitting, however, this fact, as we must, that impact is the chief of the deterioration of cast gears, but while thus we can assume that a properly cut and smoothly running cut gear is much more reliable. No definite rule is ad-

hered to, but we can safely assume that a cut gear will carry at least three times as much power as can be trusted to a cast gear at the same size, and allowing that it is made in the best manner. Speaking definitely that a cut gear is about three times more reliable than a cast gear, as already stated, we may compute its horse power by th formula:

$$\text{Horse power of cut gear} = \frac{cf\sqrt{dn}}{30}$$

$$\text{in which } \left.\begin{array}{l} c = \text{circular pitch,} \\ f = \text{face,} \\ d = \text{pitch diameter} \end{array}\right\} \text{in inches}$$

$$n = \text{number of revolutions.}$$

Electric Blue Print Machines.

Several years ago the Buckeye Engine Co., Salem, O., realized that their sun printing frames were rapidly failing to satisfy the growing demand for blue prints. They were convinced that prices asked for electric printing machines were much too high and that the machines then on the market had radical defects and complications in construction which could be overcome. They, therefore, designed and built one acording to their own ideas and obtained results which were highly satisfactory.

It was not their intention to build machines for the market, but upon solicitation several have been built and are in active service.

A perfect contact of paper and tracing must be obtained to insure a good print, and this is one thing claimed for this machine.

The cost of operating is said to be about five cents per hundred hours for carbons, plus the cost of current.

These machines are built in two sizes: "A" makes two prints 42 x 44, while style "B" makes prints 42 x 60-in.

Don't always have a grudge against your employer. He has his faults. So have you. No one is without them.

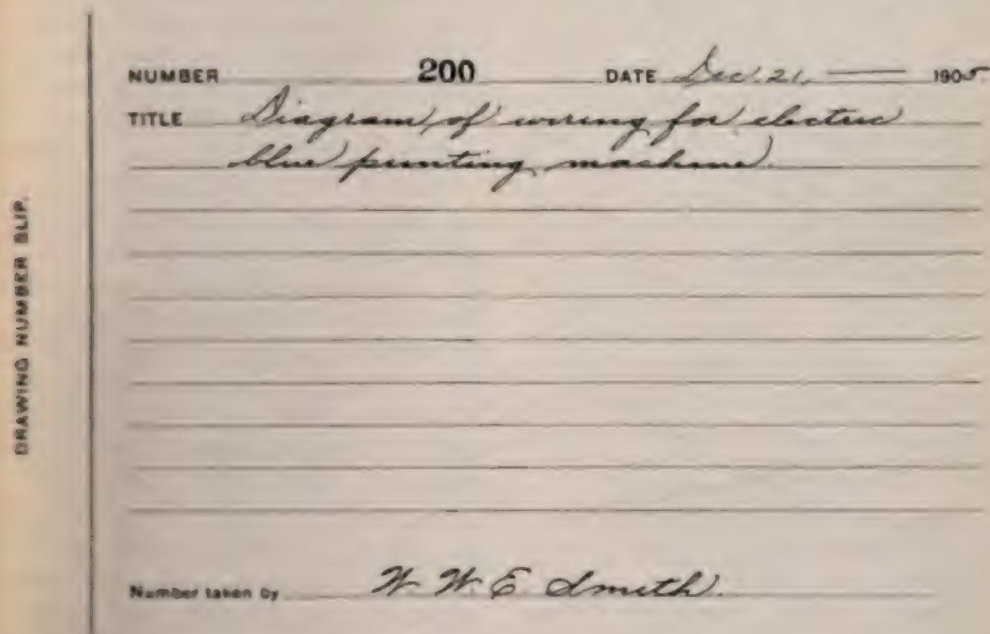
Don't forget that opportunity is a valuable part of your salary. You can get experience in no other way.

A METHOD OF ASSIGNING DRAWING NUMBERS.

IN large drafting rooms, where many drawings are produced, there is often considerable difficulty in correctly assigning numbers to drawings. It frequently happens that the same number is given to two or three different drawings, or, that through some oversight, some numbers in a series are overlooked and remain unassigned. A method adopted in the draughting department of one of the large Eastern telephone companies obviates any accident of this sort.

Pads of slips, each called a *drawing number slip*, are made up, fifty in a pad. Each of these slips measures exactly 5-in. by 8-in., so that it fits in a standard 5-in. by 8-in. desk tray. The illustration shows the wording of these slips. After the slips come from the printer, each one is numbered with a consecutive numbering machine. That is, the first slip is numbered 1 and the next 2 and the next 3, and so on. When a draftsman desires a number for a drawing he takes the top sheet from the pad of drawing number slips and uses the number on that slip for his drawing. Then, in lead pencil, he writes on the slip the date of the completion of the drawing, its title, and on the bottom of the slip his name. The slip is then given to the stenographer in charge of the card records. The records of the drawing are written up from the slips, which are filed away for a short time and then destroyed.

The method has given excellent satisfaction, there being practically no interference from the double assignment of numbers or from a tracing getting into the files without a record of it going on the cards.


DRAWING NUMBER SLIP.

NUMBER 200 DATE Dec. 21, 1905

TITLE Diagram of wiring for electric blue printing machine.

Number taken by H. W. E. Smith.

Seasoning Wood.

[illegible] resinous wood [illegible] boiling four [illegible] of Spanish [illegible] within [illegible] and [illegible] The boiling [illegible] the wood [illegible] knowing that [illegible]

in course of erection. He figured the average number of hammer strokes for nine mornings, and having learned them moved to a hotel until the new building is completed.

He discovered that [illegible] carpenter drives an average of three [illegible] a minute in soft wood and a fraction [illegible] three in hard wood. [illegible] this rate [illegible] would drive 1,[illegible] nails a day in soft wood, if he keeps up the pace steadily, and 1,[illegible] in hard wood. [illegible] hammer strokes in soft wood [illegible] in hard wood.—American Carpenter and Builder.

[illegible] Precious Metal.

[illegible] is a possibility [illegible] of the [illegible] He predicts [illegible] present large [illegible] North [illegible] Germany— [illegible]

COMPUTING A TABLE OF SQUARES.

By L. E. P.

THE value of a table of squares varying by 1-16 or 1-32 in drafting room computations is evident enough to be passed without comment. What naturally occurs to the inquiring mind is by what method are the extension tables now in print computed.

The great labor involved either in direct multiplication or in the use of logarithms suggests some "short-cut" process.

The writer made use of such a short-cut in the construction of a small table from 0 to 50 by 1-16, and while a better method may have been employed in computing the printed tables the process proved exceedingly satisfactory and expeditious.

It is based on the use of series of differences, and can best be described by a concrete example:

1	1		
		3	
2	4		2
		5	
3	9		2
		7	
4	16		2
		9	
5	25		

The first column of figures contains the given numbers; the second, the squares; the third, the difference between two adjacent numbers in the second column, and the fourth, the differences taken from the third column, which are constant.

It will be noted that given the topmost figures in each column, all the others may be derived by simple addition; that is, by reversing the process of taking differences. This is true not only when the numbers increase by integers, but also when the increment is fractional, and it may be shown to be generally true algebraically.

Let x be the number, a the increment—(1-16, 1-32, or whatever else may be selected.)

We can then express the series of differences in general terms as follows:

No.	Sq.	1st dif.	2nd dif.
x	x^2		
		$(2x+a)a$	
$x+a$	$(x+a)^2$		$2a^2$
		$(2x+3a)a$	
$x+2a$	$(x+2a)^2$		$2a^2$
		$(2x+5a)a$	
$x+3a$	$(x+3a)^2$		$2a^2$
		$(2x+7a)a$	
$x+4a$	$(x+4a)^2$		

These are taken exactly as were the numerical differences above.

The second differences ($2a^2$) being constant show that the process is applicable for any value of a.

Suppose we desire to construct a table beginning with 5, increasing by 1-16. The first step is to find the top row of figures and the table is in the following condition, ready to be completed by simple addition.

No.	Sq.	1st dif	2nd dif.
5	25.0000000		
		.62890625	
$5\frac{1}{16}$			.0078125
$5\frac{1}{8}$			.0078125
$5\frac{3}{16}$			.0078125

Here $x=5$ $a=\frac{1}{16}=.0625$

$(2x+a)a=.62890625$

$2a^2=.0078125$

The column of first differences may now be found by adding successively to the adjacent number the constant .0078125 and the column of square by adding to the given square the number adjacent to it in the column of first differences.

No.	Sq.	No.	Sq.
5	25.0000000	$5\frac{1}{4}$	27.5625000
	.62890625		.66015625
$5\frac{1}{16}$	25.62890625	$5\frac{5}{16}$	28.22265625
	.63671875		.66796875
$5\frac{1}{8}$	26.2656250	$5\frac{3}{8}$	28.8906250
	.64453125		.67578125
$5\frac{3}{16}$	26.91015625	$5\frac{7}{16}$	29.56640625
	.65234365		.68359375
		$5\frac{1}{2}$	30.2500000

2nd. dif. = .0078125

For convenience in making the additions the work may be arranged in one column, as shown with the first differences written between the required squares.

The 2nd differences, being constant, need only be written once on the edge of a separate slip of paper and brought adjacent to each first difference for addition.

A not inconsiderable advantage of this mode of procedure lies in the fact that the operations are self checking and that once properly started can be carried on by any one who can perform the operation of addition.

Binding Papers.

You will need a pair of wooden blocks the size of papers when trimmed smooth on edges, which is best done in a print[illegible] shear [illegible] a clamp, 2 strips of [illegible] wide and long enough to cover the back of your volume, [illegible] to spare at [illegible] good stiff paste. [illegible]

[illegible]

roll under in passing down. Cover paste board with marble paper, cloth, or front cover of one of the papers bound. Adjust blocks to edge of back and clamp well and let dry. If you have done your work neatly you will have a book to be proud of. I bind all my technical papers this way. I keep my Practical Carpenters in a letter file till I get the number desired and then bind them.—Igno Ramus, in Practical Carpenter.

Measures Unseeable Lengths.

The 250th part of an inch is a millimeter. The 2,000,000th part of a millimeter is what Dr. P. E. Shaw of England is measuring. The unaided eye cannot perceive much less than one-tenth of a millimeter. With the help of a microscope the eye can see as little as 1-5,000 millimeter. The measuring [illegible] used for engineering gauges will detect differences of 1-8,000 millimeter. By using interference bands of light we can perceive movement of 1-[illegible] millimeter. In the optical lever a beam of light falls on a pivoted mirror [illegible] the mirror at a [illegible] the pivot the [illegible] large angle. By [illegible] of the body by [illegible] millimeter may be detected. The most modern and sensitive method [illegible] Dr. Shaw's [illegible] in 1900, and has now been improved so that it [illegible] less than 1-2,000,000. It is not [illegible] by the hand, but work[illegible] of rubber, which [illegible] around a pulley to [illegible] This is done to avoid the [illegible] touch and the [illegible] hand. Many precautions [illegible] cleanliness must [illegible] insure its operation.

[illegible] manufacturer never [illegible] his business.

READING DRAWINGS.

By Prof. A. Edward Rhodes.

A WORKING drawing is a drawing which gives all the facts of form, size and structure of an object. Its purpose is to show the workman with accuracy all the dimensions of an object which is to be made. This object may be one already made, or it may exist only in the brain of the inventor or designer. A working drawing is, therefore, composed of as many geometric views of an object as are necessary to the complete understanding of that object.

A geometric view shows but two dimensions of an object. For such a view the object is supposed to be placed not only directly below the eye, but as though each part (point) was directly in front of or directly below the eye. The different views required in a working drawing are named from the part represented in the view. Thus: the front view represents the view obtained by looking directly at the front of the object; the top view represents the view obtained by looking directly down upon the top of the object, and so on with the other views.

Working drawings must have two views of the same solid. Illustration: no one can tell what kind of a solid figure 1 represents, because only one view of the solid is shown and hence it may represent a solid whose cross-section is a triangle, a square, or an hexagon. Now notice, figure 2 shows two views of one solid; these two views give a complete idea of the form of the solid represented. The lower view shows the height and that the edges are parallel; the upper view shows the form of the ends of the same solid, and with such a drawing before him any mechanic can shape the material with a certainty that can be obtained in no other way.

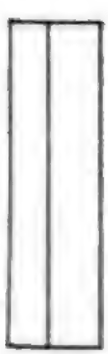


Fig. 1.

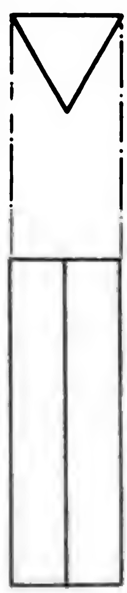


Fig. 2.

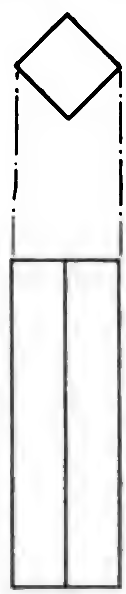


Fig. 3.

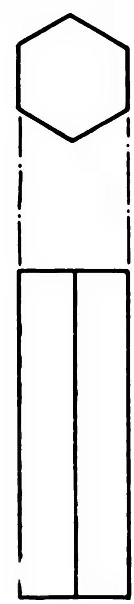


Fig. 4.

[illegible] look at the lower views of [illegible] 3 and 4 these views appear to [illegible] the same solid as figure 2, but [illegible] views indicate that figure 3 is [illegible] and that figure 4 is triangular [illegible] views (in this case) may be [illegible] of the solids, and the [illegible] plans of the same solids, gen[illegible] plans and elevations or top views [illegible] views.

[illegible] necessary to multiply the number [illegible] as the details of the objects in [illegible] and as the construction becomes [illegible] complicated, but it is not often [illegible] that more than three out[illegible] are required. Yet there are [illegible] views of any rectangular ob[illegible] top view, bottom view, [illegible] back view, left side and right [illegible]. In addition to these there [illegible] views as are [illegible] understanding of [illegible] details.

[illegible]

The History of Babbitt Metal

[illegible]

Isaac Babbitt was born in Tau[illegible] Massachusetts, on July 26, 1779. [illegible] learned the trade of goldsmith, a[illegible] 1824, in his native town, made the [illegible] britannia ware produced in the U[illegible] States, but this enterprise prove[illegible] successful. He then removed to B[illegible] and entered the employ of the [illegible] Boston Iron Works, and in 1839, [illegible] an employe of this establishmen[illegible] produced the invention which has [illegible]petuated his name. For this inve[illegible] he was given a gold medal fron[illegible] Massachusetts Charitable Mech[illegible] Association, and afterward Con[illegible] granted him the sum of $20,000 as [illegible]ward. In 1844 the invention was [illegible]ented in England and in 1847 in R[illegible] After devoting some time to the [illegible]facture of metals he engaged i[illegible] [illegible] so that his [illegible] has become almost a household [illegible] [illegible] at the McLane As[illegible] Somerville, Massachusetts, on Ma[illegible] [illegible]

[illegible] the patent spe[illegible] [illegible] is made for the al[illegible] [illegible] the ordinary [illegible] britannia [illegible] parts [illegible] copper [illegible] latter [illegible] than that now [illegible] genuine babbitt, which is com[illegible] [illegible] parts and [illegible] copper [illegible] parts [illegible] same as [illegible] bearing which [illegible] surface of the [illegible] the alloy is [illegible] harder than [illegible] employed [illegible] Isaac [illegible] the al[illegible] [illegible] succession

PRACTICAL PERSPECTIVE.

By I. B. Rich.

W' many draftsmen never wished 'or artistic abilities enough to draw sketches for the patternmaker and mith in perspective? It is so to show just what you to in this way, in one ı and the man who can not stand this kind of a sketch has no :ss in the modern shop. But I come across mighty few drafts-vho are artists enough to do this 'y don't have to label it "this is a h" or whatever it happens to be. tches of this kind do away with nfusion of the different angles of tion, with the chances for mis-standing dotted lines and shad-ınd convey to the mind of the nan just the right idea of the vou want made.

linear perspective with its ing points is out of the question st of us and so we generally give ıltogether.

re is a way out, however, if we ıpend a little time in getting ır with isometric perspective. as no horizontal lines but the hat are horizontal in the original degrees above or below as the ıay be. Vertical lines remain ver-nd circles become ellipses. This e great advantage of being easily d and of being capable of scaling mension along the isometric Instead of taking the regulation s is usually done, let us try a gle, such as a brick, and see how y we can show the pattern maker hat we want him to know. No one can mistake the sketch in figure 1.

Suppose we have to put a few openings in this, and we simply put in the lines shown in figure 2. The dimensions tell the whole story and still no chance of mistake. Of course, a good man who can read drawings will have no trouble with any of the regular drawings, but the average man will; and then too, the three view drawing takes more time. Examples of this kind can be extended indefinitely as can be seen in figures three and four, and could be multiplied many times. These bring us to the circles which become ellipses in this perspective and which have kept some from using it in their work. As a matter of fact, this need not be the case, for the real use of such a perspective is for sketches rather than finished drawings and can very well be done free handed in nearly every case.

Isometric has a field in finished drawings, and is used by some for assembly drawings, as it shows just where every piece goes and leaves no chance of making a mistake in putting together. But more of this after we have become accustomed to its use in simpler and perhaps more practical ways.

It will be plainly seen that to draw in this perspective, requires either triangles or swiveling head T squares, and is not as easy as the other drawings. This is one reason why it has not had more general adoption as it certainly had many advantages, especially from the fact that all the isometric dimensions can be drawn to an exact scale

the same as in regular drawings.

These difficulties are obviated, however, by the use of the new, especially ruled paper, on the same order as the cross section papers, but with the lines ing each space as an inch or any other dimension, just a[s] with section paper. This known as the D-C Iso paper [illegible] will be explained in a later [illegible]

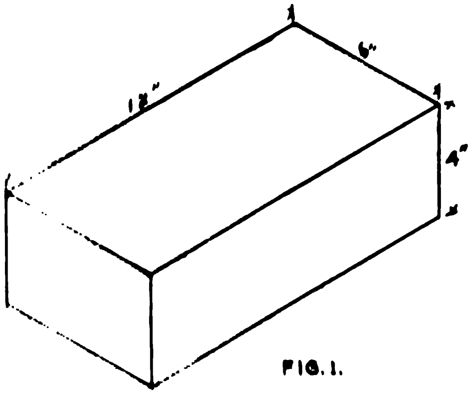
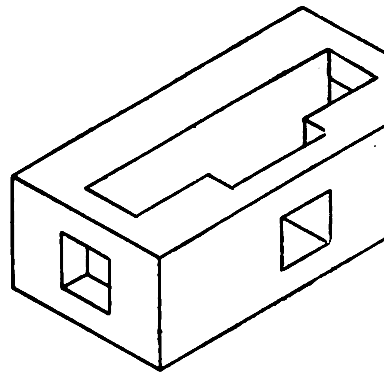


FIG. 1.



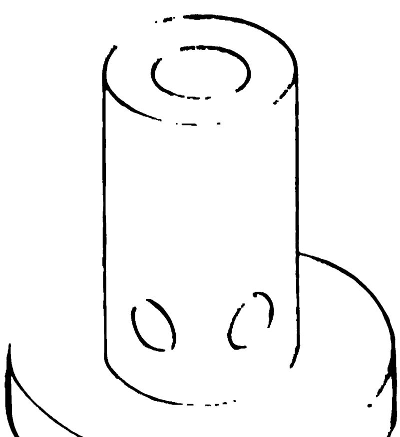


FIG. 3

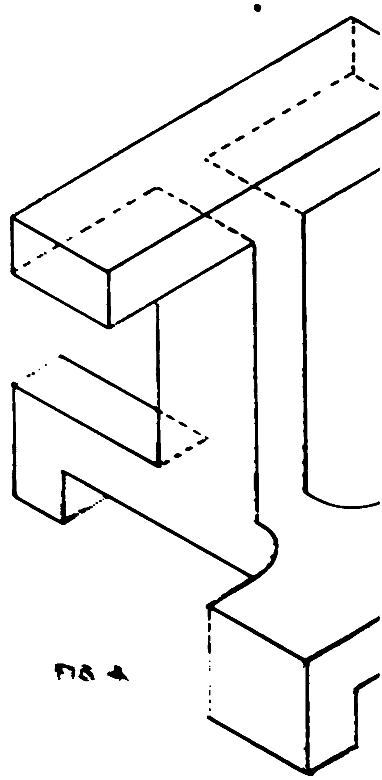


FIG. 4

[illegible] 120 degrees instead of right angles [illegible] [illegible] The subject of isometric pers[illegible] that time we will show how [illegible] applied to ordinary work i[illegible] practical way, [illegible] of ti[illegible] [illegible]

MOVABLE HEAD T-SQUARE.

VERY few draftsmen would undertake to make a movable head T-square, because a majority of them have a false idea of the accuracy required in such instruments.

The instrument makers bear down heavily on the accuracy pedal in their descriptive catalogues, especially in describing instruments made of wood, when, as a matter of fact, this extreme

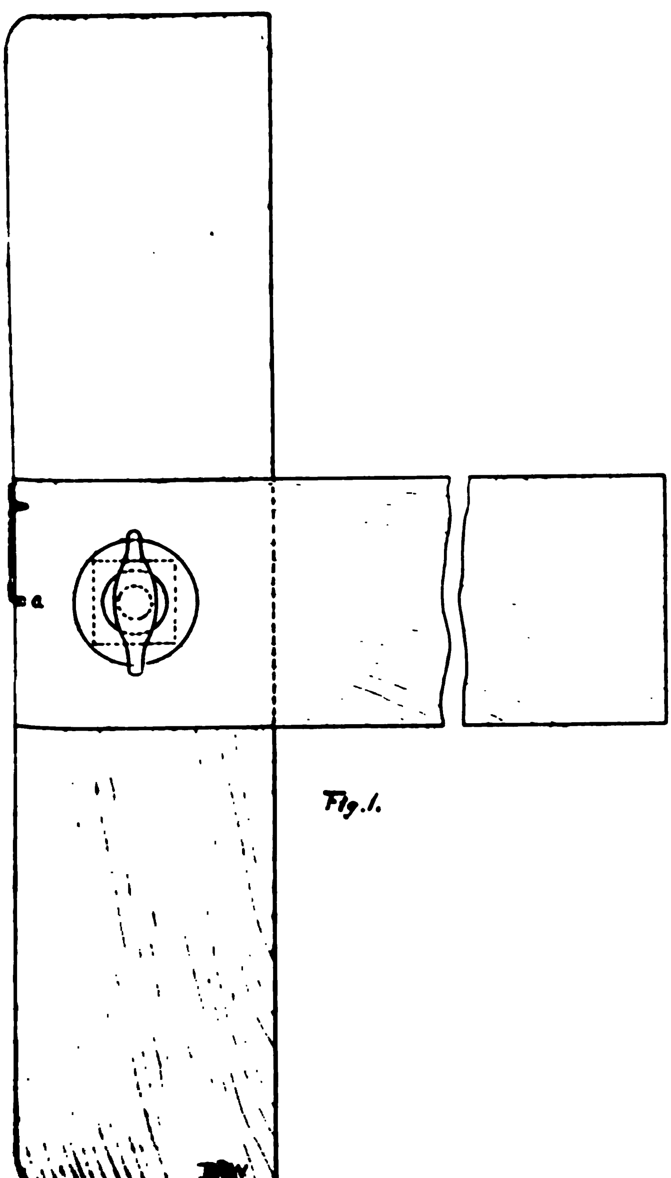


Fig. 1.

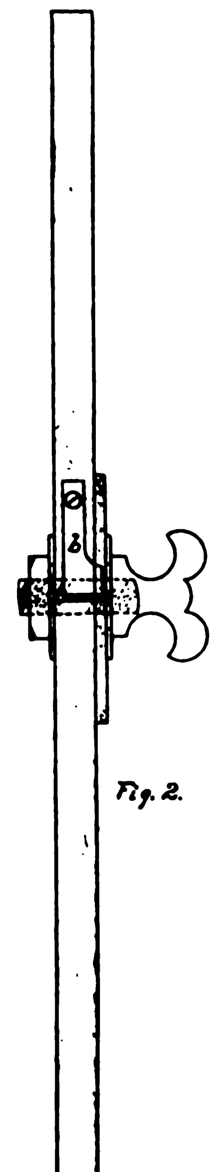


Fig. 2.

accuracy is required only in the triangles and scales.

The drawing board requires but one straight edge—the working end—and that need not be parallel to the other end or exactly at right angles with the bottom and top. With the head of the T-square against the working end of the board all lines drawn along the blade will be parallel, regardless of the inaccuracy of the other edges.

This is also true of lines drawn along the blade of the T-square, whether the blade is at true angles to the head or not, provided the blade is not so loosely attached to the head as to wobble.

The accompanying drawing represents a movable head T-square that may be constructed by anyone with a very little skill with tools.

The square should be one with the blade screwed to the head, not with the blade mortised into the head. With a fine meter-box saw, cut a kerf about one-eighth inch deep in the end, as shown at A, Fig. 1. If there are five screws holding the blade to the head, remove the center one and at that point bore a three-sixteenth inch hole through blade and head. Ream out this hole to take a three-sixteenth inch stove bolt loosely.

Take a small piece of stiff brass and file it to the shape shown at B, Fig. 2. In the narrow end bore a hole large enough to take a No. 2 brass screw. Put this in place, with the small tongue in the saw kerf and screw to the head, as shown in the drawing.

Slip a washer on a three-quarter inch long stove bolt, three-sixteenths of an inch in diameter, and push the bolt up through the hole bored in the head of the square. Slip a washer on the projecting end of the bolt and screw on a thumb nut. Screw this down tight and then remove the four remaining screws, holding the blade to the head, and the movable head T-square is completed.

The operation of this square is quite simple, as will be seen by the drawing. When it is required to change the angle of the blade, merely loosen the thumb nut, lift the spring out of engagement with the saw kerf, and turn the blade to the required angle and tighten the thumb nut. To restore it to its original position it is only necessary to loosen the thumb nut, turn the blade until the spring falls into the saw kerf and again tighten the thumb nut.

The wear on this square will be no greater than on the factory-made square, and with reasonable care it would probably last longer.

Concerning Barrels.

"Maybe you wouldn't think it," said a man with a pine splinter for a toothpick, "but I want to tell you that this country turns out 1,000,000 barrels and kegs and that sort, every working day in the year, or a yearly output of 300,000,000, and the United States leads the world in the cooperage business. You mightn't think it, either, but flour doesn't call for the most barrels, notwithstanding all the flour we produce. Cement leads the string with 35,000,000 barrels, while flour uses only 22,500,000. Sugar calls for 15,000,000, and bolts, nuts, nails, etc., take another 15. Roasted coffee, spices, fruits, vegetables, and crockery take 5,000,000 barrels each, and glassware, baking powder, distilled liquors, candy, tobacco and cheese use from 2,000,000 to 3,000,000 each, every year. Oil, molasses, dry paint, pork, glue, snuff and a lot of other articles call for their millions too, every year, not to count those already in use."

A butcher can usually contrive to make both ends meet.

CURRENT TOPICS.

aylor-Holden Co., Springfield, e prepared to receive orders for 2 of their Architectural Draw- s including stone and brick con- There are 10 plates, '9x12' er set.

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ldresses appear in our title page, will no doubt receive much of at the Colliuwood post office. rood is a suburb of Cleveland, t of the city and reached by the ,ine" branch of the Cleveland sville electric road. pe that the fresh air and country e inducive to the production of gazine. Let us hear from each

---

Dayton Pneumatic Tool Co., Ohio, manufacturers of the Pneumatic Hammer, report iness for 1905 as having been sfactory. Notwithstanding the there is a tendency toward the e year to delay purchases until beginning of the new year, an y large number of orders was re- December. The Company has ordered additional machinery yton works which will increase acity to about 300 hammers per

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aduates from Correspondence ools are more Inventive.

g at the vast expense in the al lines throughout the United we find before us dignified as compared with a half when education was looked upon as being superfluous and unnecessary. But the times being changed, and today no man or woman is worth anything who is not educated to meet these demands. It has become so important to have an education for every calling that in order to meet these inevitable demands open roads in the way of tuition by correspondence are brought in vogue. The young man who has ambition and wants to better his position starts a course from a correspondence school. This sounds easy, but just imagine what push and longing he must have in him to complete his studies! To commence with, he comes upon subjects which he perhaps has never heard of; he meets problems which only a technical man can solve; in order for him to succesfully get over this, or in order to get more explanation he has to send to his school, and in turn this state of battle continues all through his course. To help himself he ponders and thinks and reads up books on the subjects, forcing his tenacity, judgment, observation and reflection, and nine out of ten cases before he finishes his course he realizes some improvement on some part or the whole? All this being brought about by ambition to study.

We will refer to the young man whose parents are financially able to send him to a technical college. This fellow knows his father is well-to-do, and what's the result? He simply studies for the sake of study, or, rather, pastime, as it were. He very rarely is out of line from his class, because his parents are rich. We'll take this for what it's worth. He goes to college for three years, as the

[illegible] he and at the end of his term [illegible] with a diploma, which is a recognition that he has passed a certain course. The same so called graduate gets a position far beyond his ability, because of money. So, they have to do so and so; his father is associated with such a firm. It's a good thing there are not many rich men's sons who take up an engineering course or we would find that when the time comes to execute knowledge they simply would know nothing.

The writer has worked with graduates from some of the large universities who could not use a scale, and these men were the kind spoken of. While in the same place worked two correspondence men whose ability was recognized far beyond their knowledge. Therefore, who are the better men? It proves conclusively that any firm taking an honest young man who graduates from a correspondence or night school will in turn reap their satisfaction. [illegible] coming and it won't be [illegible] we have all seen [illegible] graduates from correspondence [illegible] schools [illegible] best pos[illegible] [illegible]

CORRESPONDENCE.

Springfield, Mass., Nov. 4, [illegible]

To the Editor.

Dear Sir: As a draftsman and [illegible] of your magazine, I would like to [illegible] few lines to the discussion of org[illegible]tion.

I believe that it is the duty of [illegible] man who plys the trade to be ass[illegible] together, in order to protect, as we[illegible] promote, the good and welfare n[illegible] tained by any other way. As we a[illegible] passing into a period of organizat[illegible] every kind it must necessarily follo[illegible] the workers' interest are at once e[illegible] We witness the organization o[illegible] ployers in particular, which is no[illegible] in its infancy at its present stage [illegible] game. We have only to call your [illegible] tion to the so-called "open shop" [illegible] tion. Most of the enlightened w[illegible] know what it means—to this end [illegible] are only successful with the unorg[illegible] workers. We have but four insti[illegible] [illegible] you are not confronte[illegible] [illegible] reading similar t[illegible] [illegible] Apply at th[illegible] [illegible] Manufac[illegible] [illegible] We accept [illegible] [illegible] to all who [illegible] that that means I would [illegible] earnestness a[illegible] [illegible] to protect the [illegible]

[illegible] and let [illegible] master.

[illegible] this and other vie[illegible] [illegible] Draftsman. I am sin[illegible]

[illegible]

[illegible] Alden

[illegible] Mass., Dec. [illegible]

[illegible] Editor.

[illegible] Twenty members

g profession met last night and ed the "Hampden County Drafts- Association," with headquarters in field, Mass.

r the various phases of the subject en discussed, selections from a tion, as set forth in "The Drafts- were read and commented upon, committee of five of the charter rs was appointed to draw up a ution and By-Laws, to be pre- at the next meeting.

e of the proposed names for the ation were: Springfield Drafts- Association, Hampden County nen's Association, Springfield cal Association and the Tec- Club. Hampden County Drafts- Association was almost unani- voted the most appropriate name.

matter of rooms, dates, dues and were discussed, with the object ng the constitution committee an to the concensus of opinion on ubjects.

next meeting will be held in about eks, when the enrollment is ex- to increase to about fifty or sev- e active members.

Respectfully yours,

FRED PERCY BARKER.

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ng to the efforts of W. C. Fronk, Giffin and F. P. Barker, drafts- The Knox Automobile Co., a of draftsmen has been organized city and the following officers President, W. C. Fronk; vice- nt, H. W. Giffin; secretary-treas- S. C. Abbe. These three, with Knight and F. P. Barker, con- the executive committee. Two ful meetings have been held, and owing Constitution and By-Laws :

ARTICLE 1.

Name and Object.

This Association shall be known as the Hampden County Draftsmen's Association, and its objects shall be to promote the arts and sciences connected with the art of drafting, the reading and discussion of technical papers and any other subjects of interest to the Association and the circulation of the information thus obtained.

ARTICLE 2.

Membership.

The membership shall consist of Honorary and Active Members. Only Active members are entitled to vote. Honorary membership shall consist of persons of acknowledged professional eminence. Active membership shall consist of persons who have worked one year or more at drafting in some drafting room.

ARTICLE 3.

Officers.

The officers of the Association shall be President, Vice-President and Secretary-Treasurer. These officers, together with two members of the Association, shall constitute an Executive Committee, who shall conduct the general business affairs of the Association. All of these officers shall hold their offices for one year, or until their successors are elected. The Secretary-Treasurer shall be exempt from dues during his term of office.

ARTICLE 4.

Elections.

These officers named in the preceding article shall be elected by ballot at the regular annual meeting of the Association. Vacancies occuring in any office of the Association shall be filled at the next regular meeting of the Association after the vacancy occurs.

ARTICLE 5.

Expenditures.

No expenditures, except actual running expenses, shall be authorized, ex-

... of a two thirds vote ... the Association pres- ... duly called meeting

ARTICLE ...

... Members

... member who ... all members shall ... any position va- ... within their ... Secretary shall keep ... such positions

...

... altered ... two-thirds vote ...

wishes to belong, and shall b- by two active members; same on by ballot at a meeting of ciation, a two-thirds vote of bers present electing the appl-

ARTICLE 3.

Initiation Fees and D-

Section 1. A fee of fifty accompany each application fo- ship.

Section 2. The annual du- ... shall be one dollar ... cents ... per year, pay- ... annually in advance ... ... and Decem- ...

... meeting ...

Editor.

Sir:—Please let me have a small your valuable columns to com- my letter in your October num- n I used a "non de plume" Vox In answer to "Beam Compass" ay that I did not advocate a n tots. I made mention in my a possible union or association. with "Beam Compass" in a way. ot advocate a union pure and as your correspondent points out, word union in the English e means strength, joined togeth- there we are with the same almost when we use the word tion, and it puts me in mind of a ld and influenza, which is six of half dozen of the other. Vox not stuck on himself, and has d feelings against unions and e where the difference would , if it were termed one or the Further I hold that any man conceited because he belongs to he noblest professions, it follows losely that such a man is never a d member of any Association, proof of the pudding is the eat- . Refer to the disturbances in mon labor unions, as he terms we find that it comes about by wo who think they deserve more, because they really merit it. ompass had better get more ex- about draftsmen, their salary, places some work in, and what called upon to do. I have no must be a first-class man, and position, but he perhaps will be change his opinion some day. always found it good policy to ell of every man, take the gentle- part, regardless of trade or pro- Further Beam Compass as an man should have better prin- ut him than to scorn a man be- is a shoemaker. I am led to believe that Beam Compass must have at some time given the cobler trade a trial, and having learned the trade in a short time, is in a position to give advice. But then even at that, how can a man be scorned because he earns an honest living?

Enough of that ugly "Amour propre"

Thanking you Mr. Editor for your space,

VOX POPULI.

To the Editor.

Dear Sir.—I noticed in your November issue, under the head "Current Topics," a reply to Vox Populi's letter in the October number. This answer does not in any way approach a reply, and it goes to prove that your contemporary did not understand (or rather did not care to) the sentiments contained in Vox Populi's letter. I am at a loss to know what is meant when your contemporary says, "The finest man to work for is the one who is not afraid of his job." Vox Populi referred in his letter to men who had to work 10 hours per day for $75 per month, when nincompoops (using the same expression over) made a better livelihood than a technical graduate. Vox Populi never had a job he was afraid of, as he has principle,—and very conscientious at that,—not to take a position when he can not fill it, and that he ever will be must be a matter left to himself. Perhaps your contemporary is afraid of his job, if he has any. Under the circumstances Vox Populi has given him something to think over. Then, too, Vox Populi is in a position to prove more conclusively that there are more draftsmen who are working 10 hours per day for $65 and $75. Any man who is content on this basis for always must be one of those men of whom Vox Populi made mention when he said, "There are men of no account in every class." I will quote these lines for such

men, and is applied only to men who are worth more and will try to get their prices:

> **"Some time ago they used to sing,**
> **A rather good old song,**
> **'Man wants but little here below,**
> **Nor wants that little long.'**
>
> **But nowadays the tune is changed,**
> **With music to the rhyme:**
> **'Draftsmen want what they are worth,**
> **And want it all the time!'"**

Thanking you, Mr. Editor, for your space, I am "Up for More,"

VOX POPULI.

Civil Service Examination.

The United States Service Commission announces an examination on February 20-21, 1906, to secure eligibles from which to make certification to fill four vacancies in the position of draftsman (permanent), at $4 per diem each, in the different offices of the United States Surveyors General, as follows: Two vacancies at Olympia, Wash.; one vacancy at Boise, Idaho; and one vacancy at Phoenix, Ariz. A number of temporary appointments are made to this position from time to time, and the register established as a result of this examination will be utilized in filling the vacancies in both temporary and permanent positions as they may occur.

On February 14, 1906, examinations will take place in a large number of cities for positions of engine man at a salary of $1,000 per year. Ask for Form 1093. On the same date is an examination for a machinist at $1,400 per year.

Applicants should at once apply either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any place mentioned in the accompanying list, for applications Form 1312. No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

New Plan in Railway Building.

A railway boarding camp for the laborers on railroads is perhaps the latest illustration of the generally recognized principle that the better surroundings, moral and physical, the men have the more and better work they do. The gangs of railway laborers usually work out of reasonable distance of towns, and are, therefore, practically homeless, and must depend on the companies for food, shelter, clothing and incidental necessities. The new plan, as it has been carried out, furnishes a complete boarding camp, including a cold storage system, so that fresh provisions may be at hand at any place and time. Sleeping accomodations consist of the common box cars provided by the company, to which is added portable iron framework. On this framework are installed wire mattresses with iron frames, which provide plenty of room, clean and sanitary surroundings, and abundant ventilation.

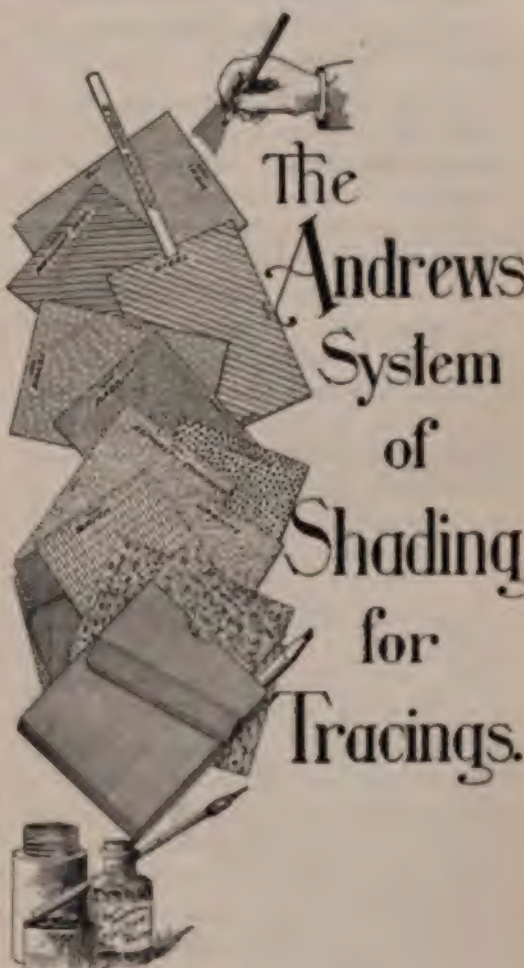
Italy in Need of Water.

Water, water is the cry of Italy as in no other land in the world; not to drink, but to create power, so that about $25,000,000 need not be spent annually, as at present, to buy from foreigners her coal for fuel. Beginning with the renowned Tiber, with 500,000 horse power, the rivers of Italy are estimated to have 767,000 horse power, of which 592,000 horse power lies in idle latency. Waterfalls, mountain streams, torrents to the number of 24,486 are credited with an annual potentiality of 2,642,000 horse power, all unused. A law providing an annual payment to the government of about 25 cents per horse power has retarded development, but beginnings have been made, particularly in the river Tierno and on a waterfall in the river Adda, and great things are foreseen in the coming days of the electro technical industry in Italy.

HE ANDREWS SYSTEM OF SHADING.

oning is a subject that has resting history. If you were to k twenty-five years before the ction of blue printing and other processes you will readily under- hy we have lost sight of some of -fashioned methods. Before blue was introduced the original was used by all concerned, and ery elaborate and expense affair,

ed with the shop print of the day. It was made on the best of so to stand the wear and tear in p. The ink used was the genuine ink, rubbed down from the stick. symbolically colored, according to terial of construction. Then, be- aving the drafting room, it was ly mounted on a suitable board or nd given a coat of shellac, which ed the surface from becoming and made it washable. This was rk of the "old school" draftsman nty-five years ago. In those days were made to represent different ls. When tracings and blue prints into general use the washing of a g with a color was discarded, and ng with the pen was adopted, and eat many large drafting rooms it und that this section lining con- too much time, and it was omitted he drawing. Also the different s, for the different materials, were to make, and every draftsman own idea of doing this class of With so many different styles of section lining it made the drawing very difficult to read in the shop. By the Andrews System of Shading all your drawings are shaded alike in represent- ing the different material, etc. You will agree with us that when a drawing is properly shaded it is easier to read.



Don't forget to speak your name dis- tinctly and in a way to impress it upon the customer's mind when you introduce yourself. It is worth more in gaining attention than any business card in the country.

Don't be afraid of a strict boss. You'll never learn anything from an easy one.

Machine Shop Philosophy.

A workman that can hold his temper can hold much else that is worth while.

It's cheaper to take up a slipping belt than to fool with resin, varnish or glue.

Some workmen say they don't need any vacation; that if the boss takes one that's all they need.

The man who keeps one eye on the clock and the other on the foreman can hardly hope to see anything except wages and a long day.

The man who is always talking of throwing up his job makes the biggest holler when there there is talk of a shut-down.

Some draftsmen would accomplish a good deal more if they didn't spend so much time in sharpening their pencils.

You can figure that the man who prides himself on being on hand a half hour ahead of the whistle every day in the year has some drawback big enough to offset it. JOE CONE.

What Water Can Do.

Imagine a perpendicular column of water more than one third of a mile high twenty six inches in diameter at the top and twenty six inches in diameter at the bottom. Those remarkable conditions are complied with, as far as power goes, in the Mill Creek plant, which operates under a head of 1,960 feet. This little column of water, which, if liberated would give a capacity of [illegible] horse power, or enough power to run a good sized ocean-going vessel. As the water strikes the buckets of the waterwheel it has a pressure of 85[illegible] pounds to the square inch. What this pressure implies is evidenced by the fact that the average locomotive carries steam at a pressure of [illegible] pounds to the square inch. [illegible] it like snow before a jet of steam. boulders, big as city offices, woul[illegible] ble into ravines with as little effo[illegible] clover burr is carried before the [illegible] stream on a front lawn. Brick[illegible] would crackle like paper, and the [illegible] skyscrapers crumble before a stre[illegible] that of the Mill Creek plant. It [illegible] powerful waterwheel to withsta[illegible] tremendous pressure. At Butte [illegible] Cal., a single jet of water six in[illegible] diameter issues from the nozzle [illegible] tremendous velocity of 20,000 [illegible] minute. It impinges on the buc[illegible] what is said to be the most p[illegible] single waterwheel ever built, caus[illegible] later to travel at the rate of nine[illegible] miles an hour, making 400 revolu[illegible] minute. This six-inch stream ha[illegible] pacity of 12,000 horse-power. Th[illegible] for operating the plant is conveye[illegible] Butte Creek through a ditch a[illegible] charged into a regulating reservoi[illegible] is 1,500 feet above the power hous[illegible] steel pressure pipe lines thirty in[illegible] diameter conduct the water to the [illegible] house.—The World Today.

Electricity Gains on Stea[illegible]

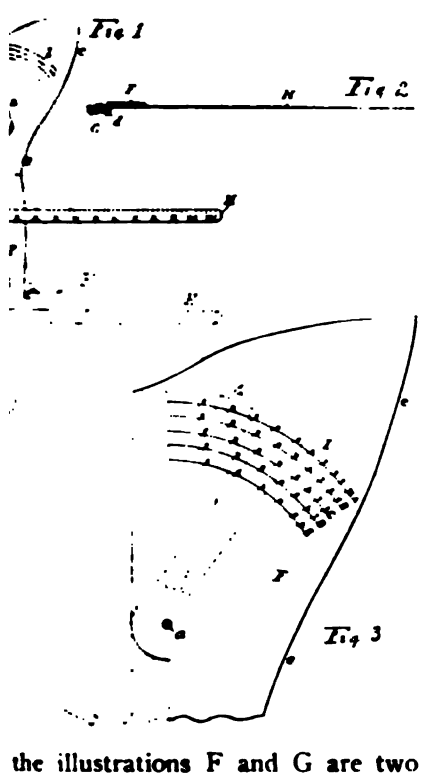
New York city plans to rece[illegible] railroads by electric traction, and [illegible] is experimenting with the mo[illegible] electric system, with a view to it[illegible] tion in the government railway[illegible] present tests relate to an 18,000-v[illegible] [illegible] system. A number of tests [illegible] made to learn the best operating [illegible] to use in the working of the line [illegible] the various local conditions. T[illegible] [illegible] of the twenty-five-ton [illegible] has two [illegible] axles, each [illegible] [illegible] horse-power motor work[illegible] twenty-five [illegible] Two locomoti[illegible] be coupled together and controlle[illegible] a single point. The pneumatic [illegible] system is used for the locomotives

New Inventions.

: following inventions have been lly reported for Brownings Maga- ›y C. LeRoy Parker, Solicitor of ts. 707 G Street, Washington, D. C.

E FOR GIVING LINEAR MEASURES OF FRACTIONS.

s construction, invented by Edward ›llet, is a mechanical device for y and conveniently showing in measures, as upon a scale of equal fractions of fractions and frac- of mixed numbers of any given ›f measure, thereby avoiding trou- me calculations.



the illustrations F and G are two parts or members of the device, ly made of strips of sheet metal, r overlapping and joined side by by a pin a, common to both, so as m thereon as a pivot. The member r G, which may be regarded as the body of the device, is formed with straight parallel edges, the right hand edge being radial with the pivot pin a and the bar being graduated at b below the pivot, as shown. The division marks of the scale b, indicating the units of measure and fractions thereof, extend transversely of the bar, the unit-marks being numbered in regular order downward from the pivot pin a. These units of measure may be of any length convenient or as may be required for any particular work, those shown on the part G being commonly three-fourths of an inch subdivided into halves and fourths as shown. The broad bar or pivotal member F of the device is marked also with a series of curved scales I, concentric with the pin a, each scale being formed of a series of unequally spaced radial marks c.

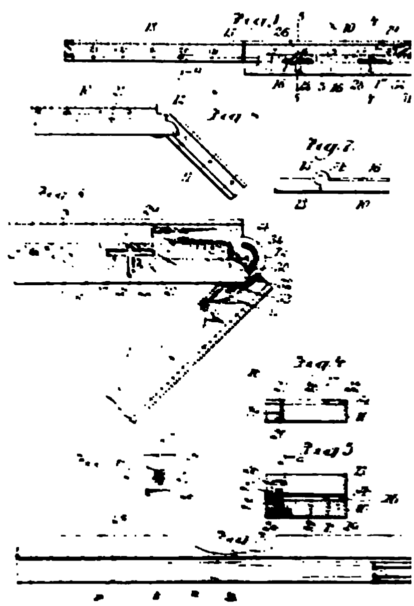
In contemplating the curved scales I the figure of the scale at the edge of the body G when set must be regarded as the numerator of a vulgar fraction and the terminal figure or number of the scale as the denominator—that is to say if, for example, "2" of scale A be regarded, it means two-tenths of some distance indicated by the scale b on the body G, or, likewise "4" on scale D would mean four-sevenths of some measure on scale b of the body G. It will be observed further that the length of the unit measure marked on the body G is immaterial and only a matter of convenience, and is wholly independent of the length of a scale unit of the sliding bar H, it being only necessary that the scale b be regarded and read in the same terms—inches, feet, yards, etc.—as the scale marked upon the bar H. Regarding the position of the bar F, it is set to indicate one-third of six-inches, the scale mark on the bar H, numbered "2" and indicated by the radial edge of the bar F, being two inches from the body G, and this wholly without regard to the distance the scale mark

numbered "6" on the body G is away from the axial point a. If the scale marked on the bar H be a scale of feet or of yards or other intervals, the device as set would give the distance of one-third of a foot, yard, etc., with the same accuracy, and in determining this position of the bar F it may be turned either to the scale mark "3" of scale B, one-third of nine, or to "2" of scale E, two-sixths of six, these two marks being in the same imaginary radial line, and what is true of "6" on the scale b is true of every other number on the scale. If the slide bar H were, for example, set at "13" on the body G, as shown by dotted lines, the device would give one-third of thirteen upon the bar H, measured between the opposing edges of the members G and F.

PROTRACTOR RULE

This invention is a combination rule and protractor and, as illustrated, comprises central sections 10 and 11, connected by a hinge 12, and outer sections 13 and 14, hinged to the central sections at 15 15. This rule is graduated as is customary. The section 10 is thinner than its companions, there being a depression at its inner side preferably extending for its full length, and in this depression is mounted a connecting member or blade 16. Through the blade are longitudinal slots 17 and 18, which receive projections from the section 10. One of these projections may consist of a pin or somewhat loose rivet 19, having its outer head 20 countersunk in the rule section, while its inner head 21 is ... the slot 17 similarly beveled at 22 so that it lies flush with the surface of the blade which is also in the same plane as the adjacent sections when the rule is open. The other projection ... engaging with the slot 18 is shown as in the form of a clamping scr[ew] which engages a nut 24, sunk in a ... in the outer side of the section 10.

When the projections from the [section] 10 are within the openings 28 fr[om the] longitudinal slots, the rule may be [folded] in the usual manner, the project[ions] moving through the groove in th[e sec]tion 11. If it is desired to use t[he de]vice as a square the blade is [swung] outwardly until the projections ar[e situ]ated within the openings 29. A[t this] time the projection 32 is with[in the] straight portion 33 of the section-g[roove] and its engagement with the side[s] of said groove holds the rule secti[ons at]



ninety degrees to one another. [The] parts may be locked in this posit[ion by] the clamping screw. For any in[terme]diate angle it is only necessary to [swing] the blade so that the projection[s are] within the slots 17 and 18. The ... sections may be swung in eith[er] direction and set by means of the ... and there clamp[ed by] the screw. The inventor of this [device] is Charles Jones of New York.

RULING PEN.

invention, recently patented by
h Kern, is designed to provide
whereby the leaves of a drafts-
ing pen may be quickly and eas-
rated for cleaning and then re-
instantly and accurately to the
operative relation to produce a
the same width.

wo spring leaves a and b of the
adjustably connected by means of
w c, the lower leaf a having a
l aperture for engagement by
aded end of the screw and the
smooth opening for the shank
said screw, which is provided
usual milled head c'.

screw d a clip e is pivotally se-
one extremity to the upper pen-
at a point between the adjusting

Fig 1.

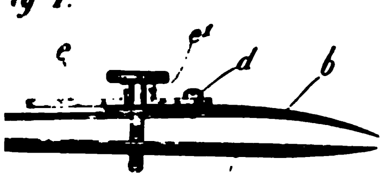
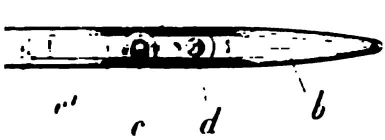


Fig. 2.



nd the leaf-tip, the other extrem-
he clip extending along the pen-
ard and adjacent to the handle,
be within convenient reach of
er of the draftsman.

intermediate portion of the clip
ded with an upwardly extending
which, together with body of clip,
rated and cut away at one side,
a U-shaped opening or recess
reception of the shank of the
when the clip is in the closed po-
The top of the boss abuts against
the under side of the milled head c' and forms a stop, limiting the extent of separation of the leaves a and b.

By the construction the draftsman can, when the pen needs cleaning, throw the clip e to one side, thus allowing the leaves of the pen to spring apart a distance equal to the width of the clip-body e plus the additional height of the boss e', the leaf b of the pen itself contacting with the underside of the head c'. After cleaning the leaves are pressed together and the clip swung into position, with the boss under the head c', when it is obvious that the tips of the pen leaves will occupy the same relative position as before cleaning and the line made thereby will not differ in width from those previously made.

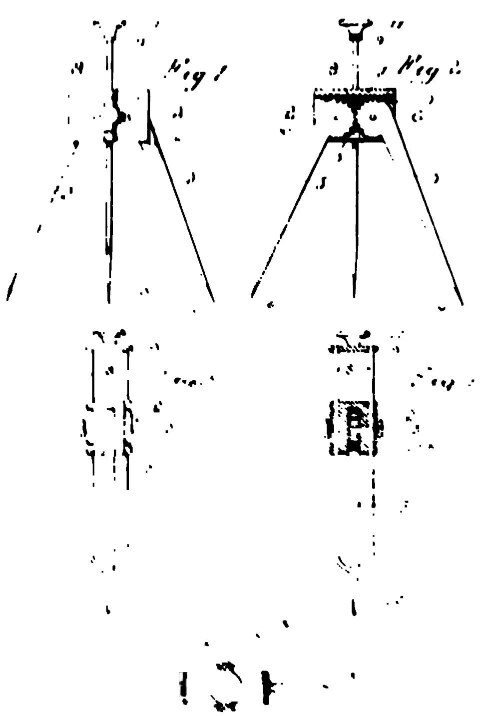
DIVIDERS.

This invention of Humbert Amendt is particularly designed to provide an instrument by means of which the center of a circle or line may be readily determined.

The body portion of the instrument is provided with a vertically disposed slot 2, which extends from one edge of the body portion to the opposite edge, forming a recess or slot in which the legs 3 3 of my improved instrument are mounted. These legs are tapering in form and terminate in points 4 4. The upper ends of the legs are sector-shaped and are provided with teeth 5 5, which when the legs are pivotally mounted in the slot 2 by pins 6 6, are adapted to mesh with one another, whereby if one of the legs is moved its opposing leg will be correspondingly moved and in unison with the first named leg.

The sides of the head or body portion 1 of the instrument are provided with vertically disposed bosses 7 7, and in these bosses are slidably mounted rods 8 8, the upper ends of which are con-

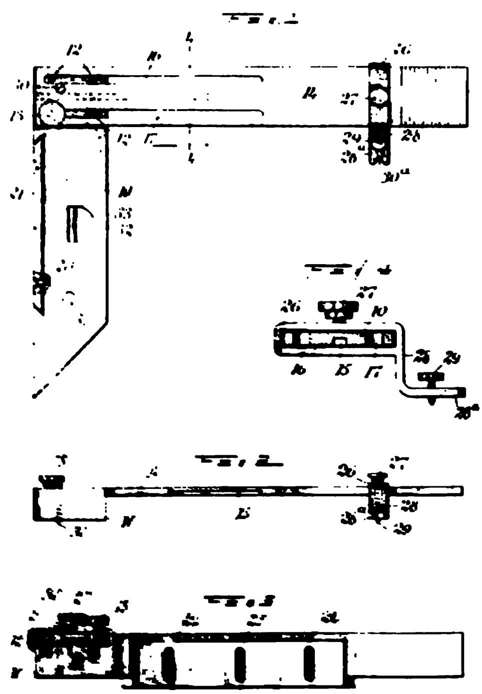
nected by a cross head 9, while the lower ends of the rods terminate in a common point 10. The cross head 9 is provided with a knurled button or knob 11, whereby the rods can be gripped in case it is desired to adjust the same, these rods serving functionally as a pivotal point or fulcrum for the legs 5 5 when the instrument is used as a compass or dividers.



The instrument can be used for numerous purposes by draftsmen. For instance, should it be desired to determine the center of a circle the legs 5 5 are separated [illegible]

[illegible]

It will be noted that in the outer edge if the handle is a recess 20, which is undercut to its ends to furnish ways in which moves a gauge member 21. In this gauge are slots 22 22 and 23. into the first two of which extend guide projections or screws 24, while through the opening 23 and threaded into the handle operates a clamping screw 25. When the gauge is fixed in alignment with the handle, it in no wise affects its ordinary use; but by loosening the clamping



screw, dropping the gauge and again securing it in place it furnishes a guide [illegible] which may be brought into contact with the work.

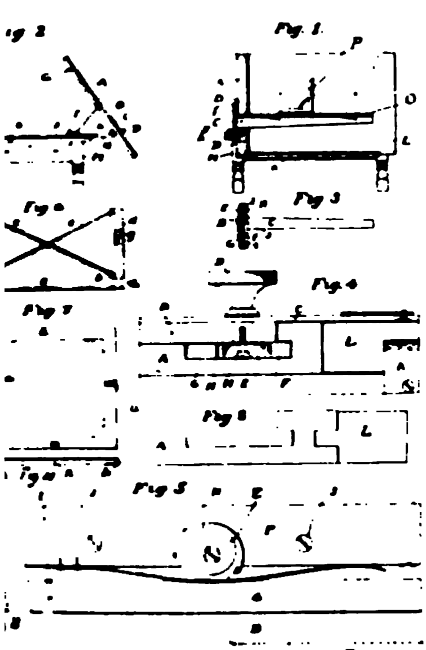
Surrounding the blade is a member [illegible] which passes a clamping screw [illegible] for engagement with the blade. [illegible] one side of the member depends a [illegible] having a laterally extended portion [illegible] which lies in the plane [illegible] the underside of the handle, so that its contact with a surface on which it

be placed will hold the square hori-ally or parallel to said surface. ugh the foot of this supporting ber is threaded a screw 29, having duced or pointed end, which upon g turned down below the foot may sed as a marking point. This may ither employed to score lines parallel n edge against which the inner face e handle or the gauge 21 is placed. pointed screw 30, operating through juncture of the blade, and handle be turned below the surface of the lie to serve as an axis or center t about which circles may be struck. hifting the blade upon the handle, as been previously described, this screw must be of course raised above the dle.

DRAWING BOARD.

806,850—Lewis Sommar—Dec. 12, 1905.

is drawing-board is shown in the mpanying illustration, provided with square, which is removably and ad-bly secured thereto. The side of the drawing-board frame a is provided with the grooved strip A. The elevation of the right-hand side of the grooved strip A, attached to the drawing-board frame a, equals the thickness of the drawing-board L when in position upon the frame, and the thickness of the drawing-boards used upon said frame is equal to the thickness or elevation of the right-hand side of the grooved strip A.



A strip, K, is secured to the lower edge of the drawing-board frame a projecting above the surface of the frame in order to retain the drawing-board L in place when the frame is inclined. It is to be noted that this drawing-board frame is adapted to receive any ordinary drawing-board and permits the immediate interchange of one board for another.

To the blade of the T-square is attached the ruler O, adjustably connected thereto in such manner as to form, with the T-square blade, a pair of parallel rulers. The triangle P may be employed as an auxiliary to the T-square blade and ruler O. The use of these devices as auxiliaries to the T-square obviates the necessity for a continual shifting or re-adjustment of the latter.

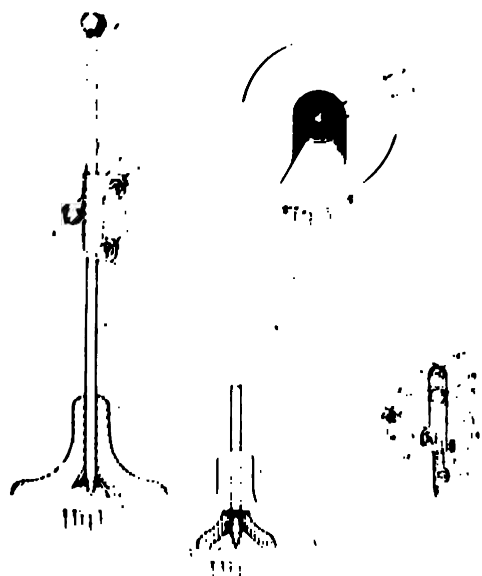
This board is the invention of Lewis Sommar.

COMBINED DIVIDERS AND COMPASSES.

No. 807,060—Joseph F. Clutter—Dec. 19, 1905.

This instrument, devised by Joseph F. Clutter, is adapted for use as a divider, compass, scriber, caliper or compass-caliper. The base 1 of the instrument is provided with a hollow in its bottom, and also with an opening leading from the side thereof into the hollow portion, to enable the operator to determine the exact center at which he wishes to place one point of the instrument and to permit of the holding of the one point—that is, the post or upright—to the center dur-

[illegible] or method of forming a [illegible] of using the



instrument otherwise, as for the purposes of determining diameters.

DRAFTING INSTRUMENT.

No. 8[illegible],[illegible]68. Richard Marx. Dec. 10, 19[illegible].

This invention of Richard Marx consists of a novel device for quickly finding and marking the center points from which to describe a circular arc to form a fillet or corner as the case may be, in a drawing or any structure which this is being laid out or designed by a draftsman.

[illegible] mark the center points [illegible] the various [illegible] there is [illegible] A by means [illegible] is necessary [illegible]

[illegible] of a number of holes, c2, formed in the body-piece A, it being noted that these various openings or recesses are so placed that when the arm is held immovable by reason of the entrance of the pin c1 in one of said recesses a center point c3, carried by the extreme end of said arm, is in a line joining the center of the pivot with the center, from which one of the arcs of a projection a or a recess b is described.

Fig 1

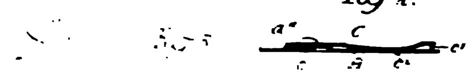


Fig 2

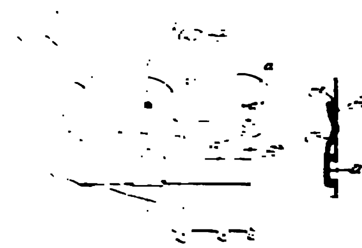


Fig 3

It will be seen that the end of the arm [illegible] is so bent or formed as to normally retain the center point c3 slightly above the level of the upper surface of the body-piece or plate A, it being therefore possible to freely move the arm C to any point upon the plate without injury to [illegible] point. At the center of each of the [illegible] projections a, a1, etc., is a relatively small opening a11, through which the [illegible] may pass.

[illegible] the instrument, if it be desired, for example, to draw a fillet hav-

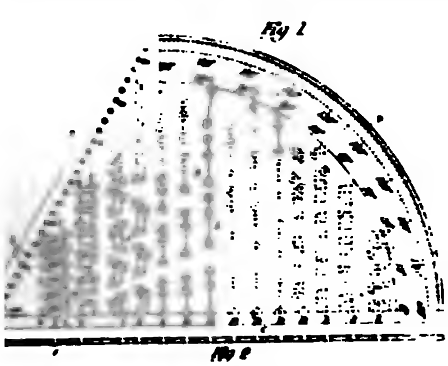
a one-fourth of an inch radius, to nect two lines at substantially right les to each other, the arm C is turned its pivot until its pin c1 enters the : or recess c2 opposite the projection ·ked "½". The instrument is then ıipulated so that the curved edge of projection a4 is tangent to both of lines between which it is desired to w the curve representing the fillet, when this condition is attained the ıter end of the arm C is depressed so t the pointer c3 pases through the ıll opening a11 and makes a hole or ·k on the drawing-paper. A com- s set to the radius of one-fourth of an ı is now used to describe the arc fin- joining the two lines.

DRAFTING INSTRUMENT.

808,511—Alden C. Cochran—Dec. 26, 1906.

'his drafting instrument, designed by len C. Cochran, combines in a single ice, a protractor, angle, engineer's le, architect's scale, and compass.

'he reference character I in the ac- ıpanying illustration designates a rality of groups of apertures which



formed in the plate A. The apertures formed in groups for forming small l capital letters, and the group of ertures designated by 3 are used for ming letters three thirty-seconds of inch in height, the group designated by 5 five thirty-seconds of an inch in height, and so on through the numerous groups which are used for forming letters from three to sixteen thirty-seconds of an inch in height. Each group of apertures is designated by a numeral representing the number of thirty-second's part of an inch of letters formed by each group of apertures. The apertures forming each group are beveled similarly to the aperture F, and the apertures composing each group are connected together by suitable vertical lines J and horizontal lines K.

INDUSTRIAL NOTES.

The Union Oil Co. has been granted a franchise to pipe oil across the Isthmus of Panama. This company secured the right from Colombia to lay pipes and later had it confirmed by Panama and the United States government. The directors think that the U. S. government will soon be burning California crude oil in the furnaces of its dredges, locomotives, steam shovels and boats. It is said that the oil can be furnished at a rate at least one-third cheaper than coal. The laying of the line will cost about $2,000,000, and in addition to this two steamers have been purchased and will be converted into tankers.

The largest single contract for railroad work ever let in the United States to one firm was awarded to McIntosh Bros. of Milwaukee, who will build about 2,000 miles of road as an extension to the Chicago, Milwaukee and St. Paul railway. It will take nearly three years to complete the work, and the project is so large that there will be employment for a year or two for practically all the idle so-called common labor which it will be possible to obtain. The average cost per mile is estimated at $33,000, so

[illegible] McIntosh Bros. [illegible] $[illegible] [illegible] in the next four or five years.

Progressiveness has obtained such a firm hold in Japan since the signing of the treaty of peace that a movement is on foot to retire the Japanese alphabet and adopt the English. This movement has made such headway that a new Tokio newspaper has appeared with news printed in English and Japanese in parallel columns, Japanese words being retained, but the English lettering being used.

An architect in America, it is said, is simply a draftsman who has landed a job. If this is true, the problem of architectural education is simply that of doing the best one can by draftsmen. It was in this belief that the Society of Beaux Art Architects some years ago opened classes in draftsmanship and elementary design [illegible] given to them in the great French school. The success of the transplanted system has been very gratifying.

[illegible]

[illegible]

May Soon Measure Infinity.

The eight millionth part of an inch is what the physicists are measuring. The twenty-five thousandth part of an inch may be taken as the limit of measurement of mechanical measures of general application. But we possess a physical means of measurement 300 times more refined than this, and free from difficulties. This is one which enables us to determine with absolute accuracy to the eight millionth of an inch, or one three-hundred thousandth of a millimeter. The foundation of this wonderful scale is the wave length of light—a quantity which is now known with great accuracy for the most important lines of the spectrum. Moreover, the method is rendered esthetically beautiful by the fact that an actual visible scale can be produced, composed of black interference bands on a brilliant background of pure monochromatic light. Further, the interval between any two bands can be subdivided into 100 parts [illegible] a micrometer eyepiece on the observing telescope.

Brazil Woods Beautiful.

[illegible] Brazil woods are recom[illegible] capitalists. Cabinet woods of [illegible] abound, are easy to reach, [illegible] easy to get. Because of the [illegible] enterprise among the Brazilians [illegible] quantities have been exported. [illegible] with the woods is bad. [illegible] wages are high. An Amer[illegible] with $5,000,000 is begin[illegible] some of the best regions [illegible] overcome obstacles by the [illegible] modern milling and trans[illegible]. An elevated swing[illegible] the logs from the [illegible] which are to be lo[illegible] roads.

[illegible] ideals. Your ideals [illegible] quality of your work.

BROWNING'S INDUSTRIAL MAGAZINE.

VOL. V — MARCH, 1906. — NO. 3

LOGGING IN THE NORTHWEST.

Fig. 1—High stumps and great waste.

THE annual value of the forest products of the United States is given in the twelfth census as nearly $575,000,000. If to this were added all waste material used for fire wood, farm material, roads, etc., a very much larger figure would be shown.

Thus as a direct source of wealth the forests of the country rank nearly with the mineral products as second to farms.

tion to the present value the for-
country have an immense value as a source of future supply and and as a protective covering for water-sheds, yet with all this value and the need for protection, the slaughter of the primeval forests go rapidly forward and some districts have been almost entirely denuded.

In the northwest, the home of the cedar, fir and pine, the work of selecting, felling, hauling and lumbering is one of the greatest industries of that portion of the country. The growth is so dense that much waste of young trees need be incurred to clear roads for the hauling of the larger and better proportioned timber.

The Forest Service of the government is now studying 1,367,000 acres of forest land in Washington and it is expected it will be of great value in throwing light on the problems of protection, waste and future timber production.

The reproduction of fir on logged-over lands is certain and rapid if the lands are burned with due precaution and the mineral soil exposed, but uncertain if a proper seed bed is not affected. The observations show that larger crops of timber may be expected from second-growth forests of fir and hemlock than from any other kind of tree.

The forest fires are, however, the greatest draw backs to conservative log-

ging. The forests in this region are very heavy and the trees very large and consequently, after logging a great amount of debris is left on the ground as shown in the illustrations. Fires easily start in such "slashes" and burn over large areas, often into the uncut forest.

The most practical method of overcoming this danger is to burn the slash as it lies at the proper season, and this plan is being tried with great success.

The burning is done from early April to the middle of May, when the slash is dry enough to burn at the same time the standing timber is too green to catch fire.

Stumps are now cut, on an average, about six feet high, and in large timber, this means the loss of a great many board feet of clear timber per acre.

Waste also occurs in the use of fir logs for skids and bridges and the leaving of merchantable logs in the tops. The mechanical means of handling the "cut" of a large section of timber lands is today receiving much attention and will, no doubt, aid in the saving of some fine pieces due to the great ease with which the logs can be reached.

The problem of skid roads and the location of hauling engines is difficult, in order that each machine may cover as much territory as possible.

In some sections, steam hauling engines by aid of wire rope and cones to be placed over the ends of the logs "snake" them to the improvised rail road where they are lifted by a derrick and stacked on cars.

With the large fir and cedar logs of the Northwest, it is necessary to roll and haul to the skid roads from the position where the tree originally fell.

A sling with heavy hooks at each end is used on the end of the logs and the line

of wire rope hooked on. This wire rope may be a mile long and thus the log goes slipping and bumping along to the first "turn." Here another line is hooked on from another direction and the log continues its journey to the landing where it, with its fellows, are transferred to cars and hauled to a "dump" in a river or direct to the mill.

The wire rope is dragged to the log pulleys or sheaves are not difficult, due to close proximity of stumps and the immense size of them.

The pulling power of the engine depends on the condition of the road over which the log must be hauled.

The drums must be large enough to carry five or six thousand feet of wire rope ¾ to ⅞ in. in diameter and any student of engineering can calculate the

Fig. 4—Loading to tram cars. Two engines in use.

by the "line" horse and the engine, anchored at some convenient place, begins to wind up the rope.

Engines in the "yard" are geared on a swivel base affording an opportunity to pull from any direction. Skid roads from the first donkey are not necessarily straight, but should be unless guide pulleys be put in some large stump.

Anchorages for both engine and guide strength of a rope of this kind made of steel and twisted as these are manufactured.

Hauling engines are all double cylinder, connected to the same crank shaft, set at 90 degrees to each other and of the familiar type seen around large buildings in course of construction in the eastern cities. The person operating this machine must necessarily be of ingenious

Fig. 6—The locomotive skidding logs.

disposition in view of the fact that the supply and machine shops are oftentimes many miles distant.

In Fig. 2 two engines are located together, one doing main hauling and the other doing the rolling of logs and handling of cars. Locomotives are a very fine adjunct to any logging company's equipment and are always built for sharp curves and rough tracks, for these roads are seldom put in any permanent manner.

In some instances, logs are rolled on tracks and skidded along over the ties by means of cable tie to the locomotive as shown in the illustration. Locomotives have been used to pump water in case of fire or to aid in loading and unloading logs at the mill pond or yard.

There are approximately 400 lumber and shingle manufacturers in the state of Washington alone and the railways carry nearly 40,000 carloads of their products every year.

Some of the large logs as shown in the illustrations average 40,000 shingles, which when laid on a roof would cover approximately 4,800 sq. ft.

Photos for this article furnished by D. Kinsey, Sedro-Wooley, Washington.

HAULAGE SYSTEM IN MINES.

By C. C. MAISON, author of "Trigonometry Simplified."

UNDERGROUND haulage, whether done by wire rope or otherwise, is always carried on in two distinct stages. The first or local haulage is done by drawing the cars from the working space to the gathering-up or central station. From the latter station the loaded cars are hauled in trains to the bottom of the shaft or slope, from the drift, as the case may be. In order to secure economy and dispatch, it becomes necessary that the local haulage be made in short a time as possible, as this work is generally done by mules, and is more costly than mechanical haulage. For the same reason the general or mechanical haulage is made as long as possible.

There are four classes of wire rope haulage which will constitute the principal divisions of the discussion; thus:

1. Gravity planes.
2. Engine planes.
3. Tail rope systems.
4. Endless rope systems.

GRAVITY PLANES.

The conditions required for successful operation is supposed, as far as economy and work are concerned, may be said that the work is done by gravitation, but this conclusion is not always a correct one, for very important reasons. The use of gravity planes are almost extinct, its place being fulfilled by steam locomotives. Many of these gravity roads were short, and the number of help utilized thereon brought the cost rather high. While the time lost in repeated stoppages for detaching and attaching ropes caused a great delay, therefore impossible to keep all the inclines running in such accord that the train from one would arrive in time to follow that of another, in consequence of which only one-fourth the coal could be handled as done now by steam locomotives. There are, however, systems of gravity haulages which are cheap and effective, but these are seldom found in the principal or primary haulages, excepting when the

self-acting incline haulage is done with an endless rope. Fig. 1 shows a device as used in the Dorrance and Red Ash mines in Wilkes Barre, Pa., where the pitch is considerable, and separate reels, connected by gear wheels, as shown, which prevents the cars from coming off the tracks in coming into and leaving the top of the incline. When they are set overboard the running on and the running off ropes, both come from the under sides of the drums or reels. The one-sided lead of the ropes is caused by the gear wheels, for these make them turn in opposite directions. These drums may be set under the tracks at the head of the

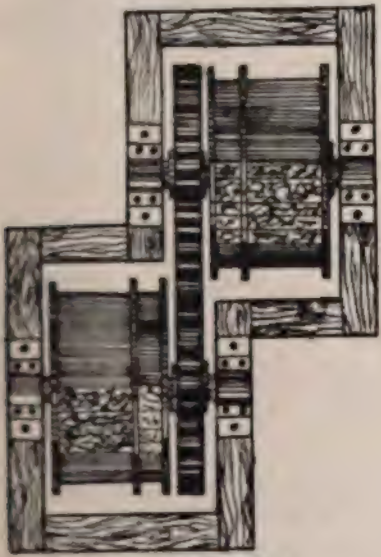


FIG. 1

incline with great advantage, if the pitch is considerable and the trains and ropes are heavy.

Such a device prevents the excessive bending of the ropes in passing over the head sheaves; that is, the ropes running off the tops of the reels when set under the tracks make a smaller angle with the line of the haulage rope than when one of the ropes comes from the under side of the drum. Therefore these reels may be said thus: They keep the lead of the ropes in order when set above the tracks, and when set under the tracks the lead of the ropes running on and off the reels is never too low.

In engine plane haulage there are two cases which are superior to all other systems. Thus: Where the seam is pitching heavily from the shaft, where no type of locomotive can be successfully used to do the haulage as cheaply and quickly. Secondly, when the road passes over two reverse inclines, where, however the pitch from or to the shaft is small or insufficient to run the train back with the rope; then locomotive haulage can sometimes be adopted with better results. Some installations of engine plane haulages and tail rope, the engine is not placed in the mine, but on the surface, and the haulage rope is conducted down the shaft, through a bore hole for the purpose. The rope for haulage is fastened to the drum of the engine and leads along the tracks, held off the ground by means of small rollers. Each car of coal is fastened to the rope and pulled to the surface.

Fig. 2 shows a form of coupling called the tail rope coupling, for connecting the different sections of the rope to run the train into a given district. All couplings aim at three things: First, to secure reliable connections; secondly, to provide a coupling link that will knock as little as possible on the rollers, and not injure the coils of the rope on the hauling drum; thirdly, to furnish a coupling in which the connections can be made and unmade in as short a period as possible. The form of coupling shown in Fig. 2 is one of the oldest and simplest in use today, therefore given here to explain the general principle, although not by

any means the best, as Fig. 3 shows another form which answers the requirements more fully and is called the "knock-off link or detaching-hook." This link or detaching hook is very handy when it becomes necessary to detach the rope from the cars when in motion, and when the hauling rope is tight. To do this successfully knock-off devices are applied. The endless rope devices of hauling can often be substituted with great advantage for either of the other three systems mentioned. The underlying principle of its action is that the haulage is done by a band or a series of bands of rope that operate the cars like an elevator chain does the elevator buckets. To realize this, however, let the loaded cars take the place of the full elevator buckets, then the inverted and empty buckets are the exact analogue of the empty cars as on one side of the endless rope there are full cars moving progressively to the shaft, and on the other the empty cars are moving inwards to the workings. The chief disadvantage of this system is that the rope undulates so much with the varying tension that the cars travel unsteadily, and in consequence of which the rope is soon damaged. The unsteadiness arises from two causes: First, on a long lead of rope resting on rollers sixty feet apart, the vibrations or undulations become deep and rigid; second, the amount of elasticity increases with the length of the rope. These two causes give to the cars the jerky movement that has been referred to.

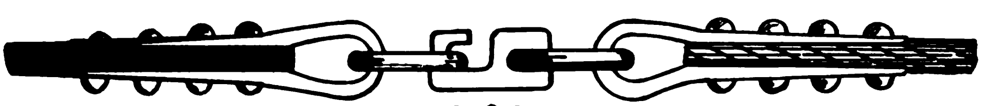


FIG. 2.

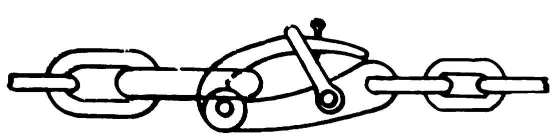


FIG. 3.

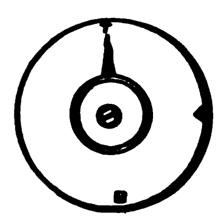


FIG. 4.

In hoisting and conveying, the position of the train or cage cannot be seen by the engineman, and, as safety is required, it must be secured by some mechanical means for indicating the position of the train or the cage. It is important that the engineman should know to regulate his steam supply and when to apply the brake, in case the road over which the train is rolling is pitching. He also should know to a foot where to stop his train or cage, and for his direction an indicator, Fig. 4, is placed in view, facing him, which is worked by a worm fixed to the drum shaft of his hoisting engine.

Don't forget that mirth is God's medicine. The man who hasn't a hearty laugh hasn't much sympathy with humanity and his chances for success are small.

HOW TO SET VALVES.

THE setting of valves is generally considered a very serious operation, especially by the uninitiated, and well it may be, as an improper setting of the valves means dollars and cents and lots of them to the owner of the machine, and also to the coal man, and plenty of profanity from the operator. I have known shovels which have been on the point of being rejected, simply because an inexperienced man had tried to set the valves, and made the shovel act like a balky horse. The operation, however, is very simple, if it is understood, and by observing the following few instructions, a lot of time, money and profanity will often be saved.

In the first place in setting the valve it is absolutely essential to have the crank pin exactly on the dead center, or at one

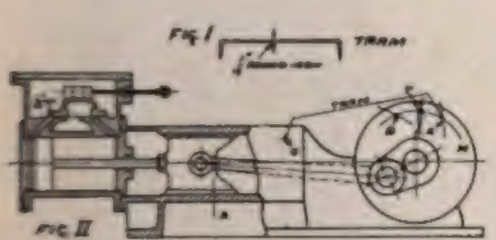


DIAGRAM FOR SETTING VALVE.

end of the stroke, and this is where the trouble often lies. One cannot determine whether the crank is on the dead center just by looking at it, as some would suppose. If you have no tram, make one to this sketch, the length depending on the style of engine. Then at some point on the frame of the engine make a center punch mark as shown in the sketch, make your tram long enough to reach the crank disc, as shown in Fig. 2. Having got this far, turn your engine over until the cross head has come to about one-half inch of the end of its stroke, then mark a fine line on the cross-head and on the guide as shown at "X." Then with a pair of dividers, with one leg in the center of the crank shaft scribe a part of a circle "M" on the crank disc near the outside, as shown in Fig. 2. Then take your tram with one leg in the center punch mark that you have made on the frame at "O" and with the other scribe a line on the circle "M" at any point "A." Now turn the engine over (always in the direction the engine runs when hoisting) until the cross-head has gone to the end of its stroke and back until the mark on the cross-head will come exactly to the mark X on your guide. Now, take the tram with one leg in the center punch mark at "O" on engine frame, make another mark (B) on circle "M." Then divide the distance between A and B with your dividers so as to get point "P." Point "P" must be exactly half way between A and B. Now turn your engine in the direction it is to run until your tram has one leg in the point "O" on frame and the other leg at point "P" on crank disc, then the engine will be exactly on the dead center. Now in this position of the engine your valve should uncover the steam port 1-16 of an inch, and if this is the case your valve is properly set for the Main or Hoisting engine. For the Swinging or Boom engines the port should be exactly covered.
—From *Steam Shovel News.*

The English denomination of money known as a pound was once a pound weight of silver in its pure state.

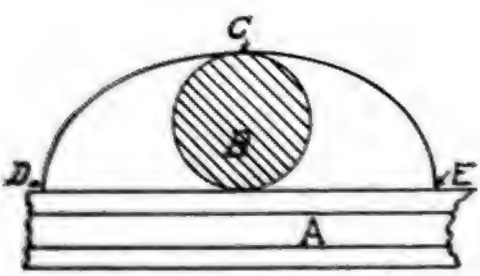
EPICYCLOIDAL GEARING.

THE proper formation of the curves of gear teeth being so meagerly understood by the majority of pattern-makers, it seems to me that it is about time the trade journals were giving the subject an airing, and to start the ball rolling I offer the following:—

Gear teeth cannot be correctly laid out with compasses, or dividers, as the curves of gear teeth are no part of a circle, no matter how large or small the circle be, or what pitch the gear be.

The curve known as the cycloid, is formed by rolling a generating circle against a straight line, or straight edge, as shown in Fig. 1.

If we consider A as the blade of a T-square, or straight ruler, and B as a loose circular disc, (called a generating circle,) and we roll the generating circle or disc one complete revolution against the straight edge, a scribing point C will scribe the curve D C E, which will be found to be half of an ellipse. The



major diameter of an ellipse thus formed will always be equal to the circumference of the generating circle, and the minor diameter equal to twice the diameter of the generating circle. Now if instead of a straight edge as in Fig. 1, we use a circular disc as F. Fig. 2, the curve produced will be the Epicycloid, and the character of the curve will be affected by the relation of the size of the generating circle to the templet F. If we use a generating circle whose diameter is half that of the templet F., a curve like R. passing through the points I. H. J., will be produced, and the generating circle in making one revolution, will go just half round the templet F. If we roll the generating circle K. against the inside of the templet F., as shown, a point in the generating circle would scribe the straight line S., which just divides the

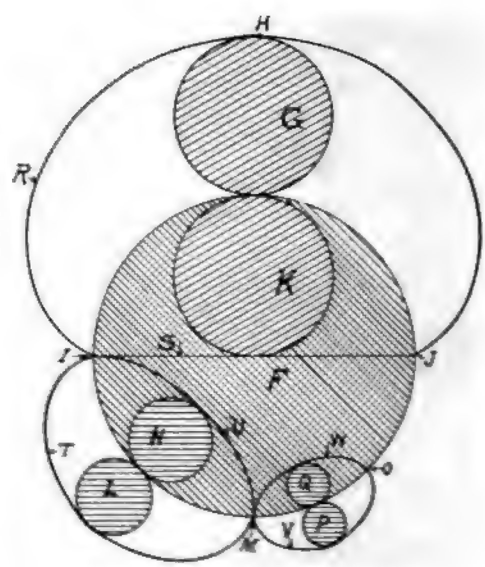


Fig. 2.

circle in halves. If we use a generating circle one fourth size of the templet F., as at L., and roll it outside of the templet F. the curve produced will be like I. T. M., and the generating circle in making one complete revolution, will roll from I. to M., just one fourth the circumference of F. Again if we take a one-fourth size generating circle N., and roll it on the inside of the circle the curve I, U, M, will be the result. If one-

size generating circles, as P., and Q., and used the curves M. V. O., and M. W. O. will be the result.

The formation of these curves is treated in the various books on Geometry, the method being to construct them by points and a curved ruler. In Fig. 3 A. is a part of a gear, showing teeth rolled with different sizes of generating templates. In order to roll the curves forming these teeth, it will be necessary to make rolling templates and generating circles as shown in Fig. 4, the template A. fitting inside the pitch line to roll the generating circle against to form the faces, and the template B. fitting to the outside of the pitch circle to roll the generating circle against to form the flanks

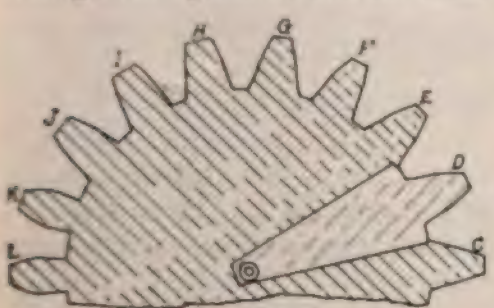


Fig 3.

of the teeth. The generating template C., Fig. 4, is made one-fourth size the pitch circles A, B, of Fig. 4, and their relations are represented by L, and N, in Fig. 2. In Fig. 3, the Teeth C. D. E. F. G. have both their faces and flanks rolled with the quarter sized generator. This makes a tooth of pleasing form and is correct where the gear is to run with another gear having the same number of teeth, but if the mate is either larger or smaller, the faces should be rolled with a different sized generator. In this system the flanks of the gear being made are to be rolled with a generator one-fourth size of the gear being made, and the faces, or that part of the tooth outside the pitch circle, is to be rolled with a generating circle one-fourth size of the mate. Now, if we were making a gear to run with one with twice as many teeth, whose diameter was twice as great, we should need another set of templets E. and F., Fig. 4, and another generator G., Fig. 4, the diameters being twice that of A. B. C., Fig. 4. With this arrangement of templets, and generators, the teeth would appear like H, I, J, Fig. 3, the flanks being the same as C, D, E, etc., but the end of the teeth would appear more blunt and stout. Now there is a system of making interchangeable gears, that is, all gears of the same pitch to work together, but where small gears are to run with very large ones, the teeth of the small gears are under-cut and are very weak. This form of tooth is represented at K, L, Fig. 3. The generating circle used to produce the interchangeable gear is one-half size of the pitch circle of a gear having fifteen teeth, for all sizes of gears of the same pitch. In this case the flanks of the fifteen tooth gear are radial,

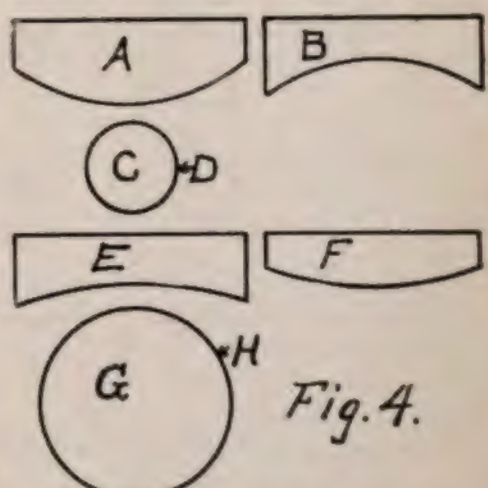


Fig. 4.

or straight lines passing through the center of the gear, and gears with less than fifteen are under-cut more and more as the teeth is made less; but as the number

of teeth is increased above fifteen the form of the teeth is much better, and in a very large gear the teeth are real stout. The generating circle, and the radial line it scribes is represented by K and S, Fig. 2. Now we can make correct gears, using one-eighth diameter generating circles, represented by P and Q, Fig. 2, but the teeth will be as much stout-flank, and pointed faces, as the radial flanks are under-cut.

The one-fourth sized generator gives the best general results, the teeth for all sizes being of good form, and reasonably stout. Then roll one tooth, and take pains to do it well.

The one tooth I use for a sweep template, as shown at B, Fig. 3, and fasten it to the center of the gear and move it to lay out each tooth. To lay out and make small gears of very coarse pitch, I lay the teeth out on a solid blank, and set the band-saw so as to give the necessary draft, saw them out, sandpaper a little, and they are ready for the moulder. If you have never taken time to think about this subject, I would advise you (especially if you are a patternmaker) to look it up and see what you can find out on the subject.

R. W. J. STEWART.

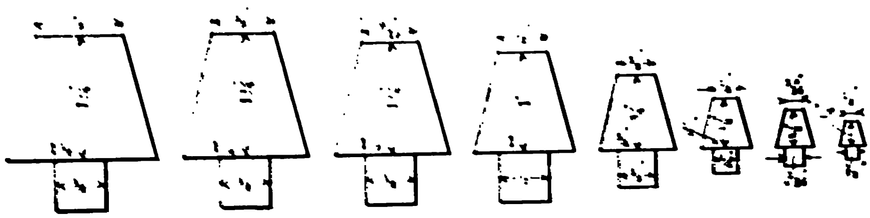
FOUNDRY PRACTICE.

Core Prints.

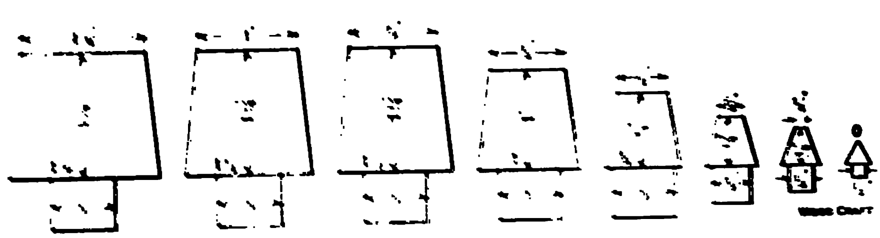
The shaping of core prints for patterns should receive such attention as will insure some degree of sameness, especially in the shop in which they are used.

there were standard prints.

To this end some discussion has been entered into in "*Wood Craft*" and Mr. W. M. Harwood says, "I am sending a drawing comparing the Gartside prints



HARWOOD



GARTSIDE

To have them so they will fit in Know-all & Co's core boxes is not much the question, still it would be far better if with the ones used in our shop.

You will notice that the taper is the same on all prints. Those shown in the

drawing are cope prints, the drag prints having one-half as much taper.

Please notice that the ½" print is the same as the Gartside, so it must look "about right" also. Notice the difference in the ¼" prints. Here are the rules if the sketch is not sufficient:

Rule 1. All prints 1¼" and under in diameter are as long as the large diameter.

The small end of the cope print is one-half the diameter of the large end.

The small end of drag prints is three-fourths the diameter of the larger end.

Rule 2. All prints over 1¼" diameter are 1¼" long. Cope prints are ⅝" less in diameter at the small than at the large end. Drag prints are 5-16" less at the small end." The above refers to vertical prints only, since horizontal prints need not to be tapered.

To the Editor.

Dear Sir:—I came across a little kink in the foundry the other day. A hand wheel was brought in. A broken-down job I thought; it looked like it. The rim, hub and four pieces of the arms were there. The hub was broken in two, but that did not matter as much as the loss of the arms. It was a hand wheel, of the same style that is used on the tail stock of a lathe. The hub was about 4' above the rim. To put in six arms all the same without the pattern was the problem. The wheel was about 18' in diameter, so the workman got a 24' flask, put down the bottom board with the parts of the wheel on it, and bedded it in. Then he made the joint of the three arms on one side of the flask. There was a center bar in the flask that came down near the joint. This one side of the flask was rammed up, lifted off, the pattern drawn and turned around with the arms on the other side of the flask. The hub was turned too, as that gave a better guide to go by, and the joint was made the same as the other side. The cope was put back and rammed up, lifted off and finished. I would state in connection with this that if a molder is making a job where there is a vacant space outside the bar, before the flask is lifted off it is a good idea to take the trowel and cut square down along the bar on the outside. Then if other things are right he will get a clean fit. Yours truly,

THOS. WATHEY

Jerusalem Engineer's Big Feat.

King Hezekiah, it seems, was troubled over the bad water of Jerusalem about 2,500 years ago, and built a reservoir outside the city gates for spring water, which was brought thither in a tunnel, the construction of which rivals the famous Simplon.

Dr. Bertholet, of the University of Basle, has identified this ancient engineering masterpiece. One of the Sirach manuscripts of this date states: "Hezekiah fortified his city by bringing water thereto, and he bored through the solid rock by means of bronze, and he collected the water in a reservoir."

The tunnel leads into the pool of Siloam and is 360 yards long. Work was carried on from both ends, as is proved by an inscription in the tunnel and by the marks of boring tools, picks, etc., which show the direction in which the excavation was made. What instruments were used for determining levels and directions, and how were errors detected? Allowing for the scientific and practical limitations suffered by these ancient Jewish engineers, their achievement excels the work of the modern Swiss and Italian experts who executed the Simplon.

An electrician is always posted on current topics.

HIGH SPEED STEELS.*

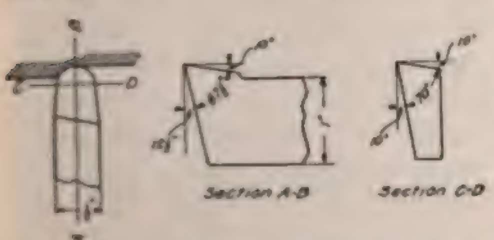
IN most manufacturing processes, it becomes necessary to change the form of materials in order to bring them to the desired shape for use. Among the metals used in the construction of engineering structures, including the almost endless variety of steam and gas engines, compressors, pumping machinery, marine and locomotive engines, special machinery and machine tools, it is evident that cast iron and steel represent by far the chief constituents of such machines. For the manufacture of all the various parts of these structures and machines there has been designed a great variety of machine tools. In these machine tools are placed the pieces whose shape it is desired to change, and a properly formed and hardened piece of steel is made to cut away a part of material. The steel used for making the tool for thus cutting the softer material is called Tool Steel. The time required to cut away the necessary amount of metal is an important factor in the cost of the piece under construction. It is evident that the relative hardness of the tool steel and the material it cuts, as well as the speed at which the cutting is attempted, will be important factors in the time required to do the work and of the durability of the tool steel used. These facts have continually exerted a potent influence upon the manufacturers of tool steel and they have constantly improved the quality of their product. On the other hand, the demand for strong and lighter materials of construction has increased the density and hardness of many materials already used, and brought into common use new materials, such as cast steel, ferro steel, chilled iron, etc., and these have imposed severer duties on the tool steels designed to cut them. The same rivalry that has existed between armor plate and the projectile intended to pierce it has existed between the tool steels and the materials they are designed to cut. Until quite recently, the rate at which tool steel could cut the various metals was from 10 to 40 feet per minute, varying with the metals cut and with the area of the cross section removed. If a higher rate of cutting was attempted, the point of the tool used became hot, lost its temper and immediately wore away. During the years 1898 to 1900, Messrs. Taylor and White at the Bethlehem Steel Works, South Bethlehem, Pennsylvania, were seeking to discover what constituents could be combined with tool steel, and what special temperature treatment it should receive that would increase its cutting speed. As the result of their experiments, there was exhibited at the Paris Exposition of 1900 a lathe using a tool steel which removed chips of soft steel at a cutting speed of from 60 to 180 feet per minute. These chips were so hot that they turned blue upon cooling. The point of the tool steel maintained its cutting edge even when running at a dull red glow. It was natural that to such tools should have been given the name of High-Speed Tool Steels.

PROPERTIES OF TOOL STEELS.

At the time of Taylor and White's first experiments, Mushet and Jessop tool steels of the self-hardening type were in general use. According to Mr. F. Reiser in an article on high-speed steel in *"Stahl and Eisen,"* January 15, 1903. they had the followir

composition: Carbon, 2.0 per cent; Tungsten, 5.0 per cent; Manganese, 2.5 per cent; chromiun, 0.5 per cent; silicon, 1.3 per cent.

The self-hardening property is called into play by the manganese, an element which favors the combining of the carbon with the iron. These steels were tempered simply by heating to a temperature of 1600 degrees F. and then cooling in air. Mushet and Jessop tools, however, did not prove durable at high speeds, although they were far in advance of the ordinary carbon steels, and chromium was substituted for manganese with good results. The chromium steels required an entirely different treatment, as was found by Messrs. Taylor and White in their experiments at the Bethlehem Steel Works.



The exact chemical compositions of the new tool steels are secrets of the separate makers, and probably vary; however, it is known that the steels contain the following elements in varying quantities: Carbon, tungsten, chromium, manganese, molybdenum and titanium. They usually run high in these combining elements, the Taylor-White steel having as high as 12 per cent of tungsten and 4 per cent of chromium, while Bohler Brothers' Styrian steel, according to Mr. Reiser, has a maximum of 28 per cent of other elements. With this increase the carbon element has greatly decreased; most of it combines with tungsten, chromium and the other elements at high temperatures, remains in that state when cooled in an air blast and forms carbides of extreme hardness and durability at high temperatures. For best results of toughness and hardness these high-speed steels require for tempering a temperature of from 2,000 degrees to 2,250 degrees F., or a white heta bordering on the fusion point, and are then cooled in an air blast, lead bath or oil bath according to the different makers. Mr. Reiser in his discussion has for this reason correctly named them "superheated steels."

ADVANTAGES OF HIGH-SPEED STEELS.

High-speed steels, due to their hardness and durability at high temperatures, retain their edge when cutting at extremely high speeds, cases having been noted in which the tool worked at dark-red heat without losing its edge. It was seen that the speeds obtained were from three to four times those obtained with ordinary carbon steels. This, of course, means an increased output for a given shop and a consequent increase in the returns. This is not the only advantage of high-speed steel. It has been proved that such steel is more economical from the power standpoint, a given power removing a greater quantity of metal per unit of time at high speed than at slow speed. Of course the total power required is increased, but the increase is by no means proportional to the increase in the amount of work done.

There is, however, one conditoin that must be carefully considered before the introduction of high-speed steels in a shop. Machine tools constructed to use the old carbon steels are limited in capacity and will not stand the heavy stresses to which they would be subjected if using high-speed steels at maximum speeds and feeds. This condition, however, is being met by the machine-tool builders, who are now designing and building especially heavy tools with powerful feed mech-

anisms with a view towards obtaining the highest possible efficiency of the steel used.

The following tool steels were used in some trials:

1. Styrian marked "Bohler Rapid."
2. Jessop's "Ark."
3. McInnes' "Extra."
4. Mushet's "Special."
5. "Air Novo."
6. "Rex."
7. "Poldi."
8. "A. and W." (Armstrong and Whitworth).

The first six came from the American market. Poldi and "A. and W." were furnished by the American Radiator Company, having been used in its foreign factories. With the exception of the Mushet, the steels used were donated for the proposed tests by the makers or agents. The Mushet was taken from stock purchased in the open market. There are doubtless other kinds of steel which could have been tested, but these eight brands were most familiar and accessible to the writers, and it is believed that they represent fairly well the brands commonly used at the present time by American manufacturers.

SIZE AND SHAPE OF TOOLS.

The size of the bars of steel from which the tools were made was ½ in. by 1 in. for the steels from the American market. The Poldi bar was ¾ in. by 1¾ in., and the "A. and W." bar was ¾ in. by 1¼ in. The shape of the tool used in the tests is shown in Fig. 1. The front clearance was 12½°, the top rake was 10°, and the side rake was also 10°. These angles were carefully maintained throughout the tests, the angles being measured with a bevel protractor after each grinding.

Experiments relating to the proper shape of tools have been made bv Professor J. T. Nicholson, and the writers were guided in selecting proper tool angles by the recommendations of his paper. Professor Nicholson says: "Tools should therefore be ground for maximum endurance in the cutting of cast iron in ordinary shop practice so that their true cutting angles are about 81°, or if they are allowed 6° clearance for working on the level of the lathe centers, they should have an included angle of about 75°.

A tool whose cutting edge was worn away .002 in. after one hour's use was considered perfect, its durability being express as 100. The ratios of the durability of any other tools to the standard will then be the inverse of the ratios of their rates of wear to the rate of wear of the standard.

The horsepower lost in driving the lathe and countershaft was deducted from the total horsepower used during the trial, the difference being the net horsepower required for cutting. This was reduced to foot-pounds per unit area of cut, and plotted as ordinates upon a base of area of cut in a diagram. The curves show that the cutting force was not directly proportional to the area of cut, but decresed as the are increased, and that the average cutting force varied from 50 tons per square inch for soft cast iron to 85 tons per square inch for hard cast iron.

It is shown that a cutting speed of 50' per minute is satisfactory, the durability being 100. If the speed is increased very materially, the durability decreases quite rapidly. It is evident that for each hardness of cast iron, the cutting speed allowable for a maximum durability exists where the vertical line indicating cutting speed is tangent to curves similar to those drawn.

(a) T

steel

iron at a rate of 25 feet per minute; (b) that all the steels tested begin to wear rapidly at speeds a little above 125 feet per minute. Between these two points, the relation between a safe cutting speed and the hardness of the cast iron seems to be definitely expressed by the curve. It would seem that cast iron of medium hardness, 100 to 120, could be cut at 125 feet per minute just as readily as at 70 feet per minute, as far as any injury to the tool is concerned. It must be remembered that this curve does not take into account the effect, on the cutting speed, of the variation in the area of cut; the experiments from which the curve was plotted were in all cases those in which the cut was very nearly ⅛ in. depth of the cut by 1-16 in. feed, so that there is but a slight variation in the area of cut in all of the experiments.

(d) Generally speaking, all the steels tested proved equally effective. It is very evident that there are great possibilities ahead for high-speed steels. Before realizing their full benefit, however, certain advances must be made. Heavier machine tools must be built. The capacity of the motors and power plants must be increased. Special hardening furnaces with temperature measuring devices must be available. More must be known concerning the chemical and physical properties of the various steels.

(e) Tool steels are now available that will cut cast iron from two to three times as fast as was possible a few years ago. When every advantage has been taken from these possibilities, the cost of manufacturing many articles should be materially reduced.

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* Extract from experiments by Professors L. P. Breckenridge and Henry B. Dirks, at the University of Illinois, Urbana, Ill.

Some Things We Read About.

The expression, "Check up this one and every other one you get," may be intended to convey the impression that you are to check only the first, the third, the fifth, and so on. Yet the writer meant you were to check every one.

One of the remarkable enterprises in England employing a large number of boys, is the Levant mine, situated at Land's End. The mine goes straight down for 2,000 feet and is worked out under the bed of the Atlantic Ocean considerably over a mile from the foot of the cliffs.

After experimenting for years with flying kites, Prof. Alexander Graham Bell has scored a wonderful success with his latest flyer, "The Frost King." In recent tests the kite rose in the air a distance of thirty feet, carrying a weight of 227 pounds, including a man weighing 165 pounds and ropes and lines weighing sixty-two pounds. The kite itself weighed sixty-one pounds, making a total of 288 pounds. The kite remained in the air long enough to have photographs taken. It rose gracefully and descended as easily, being under perfect control during the entire time.

Illustrations of the world's economic solidarity are the recent Russian influences on the security markets everywhere. Russian enlightenment and freedom promise to make marked impressions on future American farming. Henry D. Baker says that agriculture now gives employment to 87½ per cent of Russia's population, but Russian agriculture is now in a terrible condition. The Russian peasant enlightened will prove a dangerous rival.

HELPFUL KNOWLEDGE ABOUT ELECTRICITY.

By Edmund B. Moore,

Author of "Wire and Wireless Telegraphy."

PART VI.

THE use of electricity to mankind, commercially or otherwise, makes it necessary to be able to measure its quantity in amperes, its force in volts, its resistance in ohms, and in short an important item in the handling of electricity is to be able to measure its many units and measure them accurately

Among the most important electric units that are common in our every day work are the volt, ampere and ohm.

All these have been carefully and fully explained in past numbers and the reader should have attained at this stage of the serial, a good practical understanding and should have familiarized himself with the many terms, so that same will be perfectly understood as they are constantly encountered throughout the article.

It may seem to the reader a secondary matter to devote this, and possibly a part of the next number, to the discussion and explanation of electrical testing apparatus, but I will casually warn my enthusiastic reader that it is of the utmost importance, especially in the higher branches of our subject, that one should at least be somewhat familiar with their use and operation

I hardly think that there is another electrical unit so often used as is the term volt The instrument by which the number of volts may be determined, or from which the voltage is measured is called a voltmeter

A voltmeter is, roughly speaking, a galvanometer of very high resistance. There are many makes upon the market and their size and shape are often adapted to their special use. The general principles upon which these voltmeters operate are about the same, so a description

Fig. 23—Volt Meter

of a few of the most common and adapted styles will give us a fair understanding of this subject.

One of the standard makes is the Weston voltmeter. The instrument itself consists of a good sized steel magnet of a fan shape. The poles are therefore brought very near together. From these poles emanate lines of force which the magnet itself produces and this makes the space betwen the two poles a magnetic field

As these lines of force are very weak and we have learned previously that if soft iron were placed within a magnetic field the lines of force would be somewhat concentrated and greatly increased,

we will attach to the end of each pole a piece of soft iron which encloses a cylinder of soft iron that increases the lines of force. Also we know that iron has much greater permeability than air, thus it will be readily seen that by substituting one for the other the lines of force will naturally be increased.

Between the soft iron cylinder and the pole pieces there is a small space through which the induction takes place. A coil of very fine silk wound wire, mounted upon a light frame of copper is allowed to rotate through a certain fixed space. This coil is very delicately suspended by two glass pivots, one at each end. The coil is kept in place and also returned to its normal position by two light spiral springs placed at the ends, the tension of these being opposite one another.

A light aluminum lever is attached to one of the spiral springs and the end passes over a graduated dial which is visible on the outside of the instrument. The dimensions on the scale represent the electric pressure unit in volts and from this the reading is done.

The two connections with the coil are made through the two spiral springs and thence to binding posts placed upon the outside of the case of the instrument.

It is not always desired to have the current pass full strength through the coil of fine wire upon the copper frame as there is usually sufficient resistance connected on the circuit, this being arranged in such a way from binding posts on the outside that it may be increased or decreased as necessary.

All the working parts of the instrument are contained in a heavy brass case having a glass aperture for the graduated dial to which the pointer indicates. To obtain the voltage of any current the instrument is connected in municipal on the line and the depression of the contact key upon the face of the instrument closes the circuit and the lines of force produced by the current circulating the wire together with the lines of force from the magnet cause the coil-bearing the pointer to move. The movement of the pointer is in exact proportion with the E M F of the current so the number to which it points represents the number of volts passing in the circuit which is being measured.

These instruments are generally graduated with two scales, one reading in volts and the other in one-twentieth of a volt as the case may be.

When an exceedingly strong current is to be measured more resistance is inserted with the inside coil by connecting to certain binding parts. By this arrangement the instrument may be adapted to a wide range of work.

Another style of instrument used to measure the voltage of a current is known as the Carden Voltmeter.

This instrument is operated upon the hot wire principle, that is the movement of the indicating needle is caused by the elongation of a platinum-silver wire when heated by the electric current passing through it. The platinum-silver wire is 0.0025 inches in diameter and its total length is about 36".

One end of the wire is connected with one of the binding posts mounted on the outside of the instrument. It is then run down over a very delicate pivoted grooved wheel and up around a smaller grooved disc which is indirectly connected with the pointer. The wire is run from this small disc down to a second wheel similar to the first and mounted upon the same axis. It is then lead up to the other binding post from which the other connection is made.

The current passing through the wire will raise its temperature and it will at once expand. The shock in the wire is at once taken up by a spring adjustable from the outside and connected to the small disc.

It will be readily seen that the amount of expansion will be comparatively small so far as the value in determining the current's force.

It is from the expansion through the small disc indirectly that the current voltage must be determined, thus a very delicate mechanical multiplier is arranged so the movement of the pointer which passes over the graduated scale is greatly increased by the weak expansion of the unit itself.

We will not take the space to go into detail with this instrument or to describe fully the complete action because I think the reader can obtain a general idea from the above and further information in regard to this instrument would not be of the utmost importance.

These instruments are not used as much in every day work as the one first described. They are, however, very accurate and a fine reading may be obtained. These are generally constructed to read from 30 volts up to 120 volts, but by introducing with this voltmeter suitable known resistance, a much stronger current may be measured. That is, if the suitable resistance inserted in the circuit of the voltmeter is equal to the total resistance of the wire in the voltmeter, the potential difference of the current at the terminals of the instrument is exactly halved. So the introducing of this coil makes it necessary to multiply the indicated numbers on the dial of the voltmeter by two.

In measuring the volume of the electric current, or in other words, measuring the number of amperes in the circuit, we use what is termed an Ammeter. At first sight one would hardly notice any difference in this and the voltmeter, but nevertheless there is a slight change which produces somewhat different results. The outside appearance is, however, about the same.

Fig. 24—Volt Ammeter.

The first change of importance is in the resistance of the coil of the ammeter.

In measuring current strength it is desirable that the resistance of the coil be as low as possible so that a very small amount of energy will be used.

The next change is the manner in which the instrument is connected upon the line. The voltmeter measuring the difference in potential was connected in parallel with the circuit. The ammeter measuring the volume of the current is therefore connected in series on the line. This allows the entire volume of the current to pass through the instrument. It will be seen that a variation in the volume of the current carries a corresponding variance in the current passing through the ammeter and in this way the pointer indicates the volume of the current in amperes.

In these instruments the dial to which the light lever points is of a single scale while that of the voltmeter is usually doubled.

The high resistance of the voltmeter which is not necessary in the ammeter makes the instrument a little more compact. The connections are made to the two binding posts which are placed upon the outside of the instrument.

The Weston voltmeter and ammeter are of very high workmanship, and constructed of the finest material. These are called some of the most accurate instruments upon the market and are the ones which are largely used.

One good point in regard to these instruments is that they are of the dead-beat nature. That is the pointer, after the closing of the circuit reaches its position quickly and then rapidly falls at rest. This does away with the vibration of the pointer, which makes it much easier to follow weak vibrations in the current.

The cause of this excellent property is in the construction of the instrument. The moving parts are constructed of very light material, therefore, not having a great momentum, but are easily placed at rest. Also eddie currents are set up in the copper frame upon which the coil is wound. These currents are induced in the metal frame by the strong magnetic field in which the coil itself is placed.

These induced currents are in the right direction so that they react upon the original field and thus tend to stop the motion of the coil from which they were produced.

(For an explanation of this law see chapter on inductions previously given.)

One other method in which ammeters are constructed is upon the electromagnet principle.

We have explained in early chapters how a helix of wire when traversed by an electric current will attract a soft piece of iron into it. This attraction will increase somewhat as the current in increased.

In this style of ammeter the coil consists of a helix of wire, and when this is connected with the current the attraction draws a soft iron core into it and causes a light pointer, pivoted at one end to move over a graduated scale. In this way it indicates the volume of the current in amperes.

This style of instrument is not as accurate as those previously described. It is very simple in operation and can be made very cheaply.

For laboratory work the voltmeter and the ammeter are often combined in one instrument either the upper or the lower

Fig. 25—Pocket Voltmeter

scale being used for the reading of volts.

The zero mark is placed in the center and one-half of the scale graduated for amperes and the opposite for volts.

One of these instruments, a voltammeter, is shown in one of the illustrations. The screw shown at the side of the instrument is for the purpose of leveling

the instrument so that the pointer will rest directly opposite zero. Connections are made from the binding posts shown on the base.

The middle part is common to both readings. When it is desired to measure the voltage the other wire is connected to the part marked V and when amperes, to the part marked A.

For light testing purposes these voltmeters and ammeters are also constructed in a pocket size, being usually in the form and size of a watch.

One of these instruments is shown in one of the illustrations. These little instruments are practically inexpensive and are quite accurate for light reading. They are of a convenient size to be carried in the pocket and for light limited testing work they are invaluable.

To Utilize Niagara's Whirlpool.

A project has been started looking toward the utilizing of the power that may be gained from the whirlpool in the gorge below Niagara Falls. The idea is to build a pipe line between the upper and lower points in the rapids, and it is estimated that the power obtained would be twice as great as that of all the electric plants now operated at the Falls. The promoters say the project would not harm the scenic grandeur of the whirlpool.

The Joy Automatic Hose Coupler.

In order to insure a quick and positive means of complying two sections of hose, the Joy coupler was devised. The union is formed by a cam on the male end carrying offset lugs.

A quarter-turn with one hand drives these lugs home, the cam compressing the washer and making a tight joint. It is claimed that the higher the pressure the tighter the joint. The washer is a part of the male end but can not be yet when worn can be replaced easil a very small cost. The couplings made for hose or pipe connections,

female end being made for the la This style can be coupled and uncou very quickly and no matter how n hard handling it is always ready for next time.

It is made by the National Pipe Hose Coupler Co., Detroit, Mich.

Electric Railroad Up the Alps.

An electric road is being constru up Mt. Blanc on plans prepared by Ballot.

The cogwheel system is to be adoj

The road will start from the villag Les Honches, thirty-two hundred sixty feet above sea level, and will c eleven thousand, seven hundred and feet to the upper terminus.

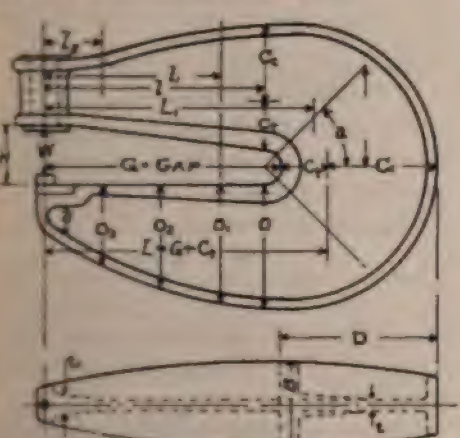
The road will pass through a tu in the northern slope.

The McGahey Oil Engine Comj have established a machine sho Basic City, Va.

PUNCH AND RIVETER FRAMES.*

By J. S. MYRES.

IN designing a punch or a riveter frame, the depth of throat or gap "G" and height of throat "H" and "h" are determined by the size and character of the work to be done. The size of the stake on riveters is usually fixed by the smallest shell required to be riveted. Then "O" must be less than this. In punches O, D, B and t are selected according to judgment of the designer. While the strength of a section increases as the cube of the depth, if the section be too deep the compression flange is so much longer as not to be economical. The thickness of the web "t" is mostly a consideration of what will cast well. For that reason it should be thickened where it joins the heavy tension flange at the end of the throat, which also takes care of the rapid transition of stresses at this point. At "t" it should usually be thickened to carry the shear, as little of the shear is carried by the flanges and the web is shallow at this point.



First, decide upon the material to be used and the allowable stresses in tension, compression and shear, all of which will depend largely on conditions. Assume the proportions of the main section and calculate for the stress. If not reasonably near the chosen stresses, correct the first assumptions and recalculate.

The frame is acted upon by a force "W" which produces a bending moment "M" upon any section equal to the force times the length of the lever arm. On the main section the lever arm is the perpendicular distance from the line of action of the force "W" to the center of gravity of the section, and is equal to "G" + "Ct."

Let L, L_1, l, l_1, &c., = length of lever arms in inches to various sections; Ct and Cc = distance from center of gravity of section to extreme fibre of tension and compression flanges respectively.

W = force applied at the die in pounds. If a hydraulic machine, this is taken equal to the effective area of the ram times the working pressure.

S = uniformly distributed tensile stress due to force "W."

Ss = shearing stress carried mainly by web of section.

St = tensile stress due to moment of force "W."

Sc = compressive stress due to moment of force "W."

Smt = maximum of combined tensile stress.

Smc = maximum of combined compressive stress.

A = area of section under consideration.

I = moment of inertia of section.

M = bending moment in inch pounds, = WL, WL_1, Wl, &c.

A = angle of section with center line of frame.

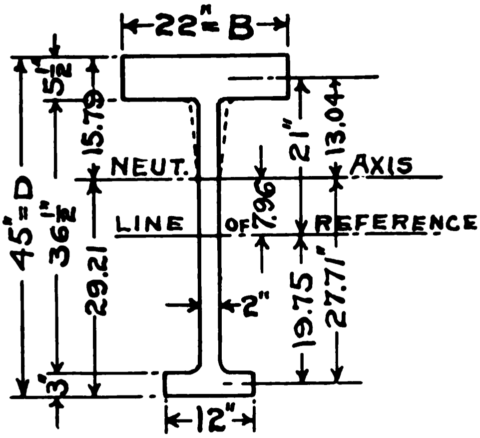
* See data sheets with this magazine for tables.

$$S = \frac{W \cos a}{A};\ Ss = \frac{W}{A};\ St = \frac{MCt}{I};\ Sc = \frac{MCc}{I};$$

$$Smt = S + St;\ Smc = Sc - S.$$

A varies as D^2. I varies as D^4.

$\frac{I}{Ct}$ and $\frac{I}{Cc}$ vary as D^3.



A section can be chosen from the tables which will fill almost any condition, the depth being proportioned to give the required value of I or $\frac{I}{Ct}$

The dimensions of the main section being assumed, determine the center of gravity and moment of inertia.

Take the moments of the different areas of the section about some line of reference, and divide the algebraic sum of the moments by the total area, which gives the distance to the center of gravity from the assumed line.

The neutral axis passes through the center of gravity of the section.

The moment of inertia is equal to the sum of the product of each area by the square of its distance from the neutral axis, plus its moment of inertia about its own neutral axis.

Example:

Design a 150 ton punch frame, to be quite rigid, but as light as consistent with good design, being mounted upon a carriage, gap to reach the center of an 8 ft. plate.

We will make this frame of a steel casting of I section, quite deep, with medium stresses to insure rigidity. W = 300,000 lbs. G = 50". Smt = 6,000 lbs. per sq. inch. Smc = 8,000 lbs.

$5\frac{1}{2} \times 22 = 121$ sq. in.	$\times\ 21 = +\ 2541$		MAIN SECTION
$2 \times 36\frac{1}{2} = 73$	$\times\ 0 =\ 00$		
$3 \times 12 = 36$	$\times\ 19.75 = 711$		
A = 230 sq. in.	1830		

$$\frac{1830}{230} = 7.96''$$

$$121 \times 13.04^2 + \frac{22 \times 5.5^3}{12} = \begin{cases} 20600 \\ 304 \end{cases}$$

$$73 \times 7.96^2 + \frac{2 \times 36.5^3}{12} = \begin{cases} 4616 \\ 8100 \end{cases}$$

$$36 \times 27.71^2 + \frac{12 \times 3^3}{12} = \begin{cases} 27600 \\ 27 \end{cases}$$

Moment of inertia, I, = 61247

$L = G + Ct = 50 + 15.79 = 65.79.$

$M = WL = 300,000 \times 65.79 = 19,737,000$ in. lbs.

$$S = \frac{W}{A} = \frac{300,000}{230} = 1305.$$

$$St = \frac{MCt}{I} = \frac{19,737,000 \times 15.79}{61,247} = 5085.$$

$$Smt = S + St = 5085 + 1305 = 6390.$$

$$Sc = \frac{MCc}{I} = \frac{19,737,000 \times 29.21}{61247} = 9420$$

$$Smc = Sc - S = 9420 - 1305 = 8115.$$

(Stresses are near enough.)

The vertical section is figured likewise, except there is no direct tension S to combine, but shear on the web.

The section at an angle "a" has $S = \frac{W \times \cos a}{a}$ to combine with the stresses due to the moment. The moment on this section is $M = WL_1$.

The vertical section being determined, the others may be proportioned from it, thus: $1 : l_1 :: O^3 : O_1^3$ or $O_1 = \sqrt[3]{\frac{l_1\ O^3}{l}}$ and all other dimensions in like proportion.

lculate the ordinates, O_1, O_2, O_3, and lay them out. It will be found the curve is not a very pleasing one, will have to be varied somewhat the web a uniform thickness, and the flanges in straight lines, keeping the area of the flanges the same as if ortioned from the above formula. k two or three sections for "St" "Sc" by finding center of gravity moment of inertia by method given t. Allow a somewhat lower stress nsion flange of the 45° section, and arge fillets for steel.

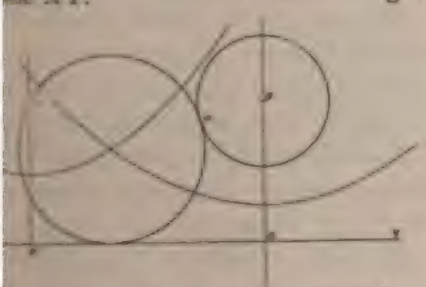
---

raw a Circle Tangent to Another Circle, a Line and Through a Given Point.

me time ago, a number of solutions given to solve this geometrical lem and a few more are here added.

r Sir:

would like to submit a solution of the lem: To draw a circle through the t P and tangent to the circle H and ine XY.



he centers of all circles passing ugh P and tangent to XY will lie in rabola, whose axis is the perpendicular PP', whose focus is at P and whose ctrix is the line XY.

hrough the center of the circle, drop rpendicular to XY. Lay of O' O" l to the radius of the circle and draw Y" parallel to XY. Now the centers ll circles tangent to the given circle the line XY will lie on a parabola whose axis is the perpendicular OO', whose focus is O and whose directrix is the line X'Y'. Hence it follows that the center of the required circle will be at the intersection of these two parabolas.

Yours truly,

H. J. MASTERBROOK.

Radioactive Substance.

In a recent contribution to the *Philosophical Magazine*, Mr. A. S. Eve makes some rather startling suggestions. He has speculated as to the possible amount of radioactive substance in the earth. Starting with a simple experiment to determine the ionization of the air, data are obtained which are used as a foundation for his argument. From his experiment he computes that if the ionization of the air has an average value equal to that which he found that this corresponds to an activity which would be produced by one-half gramme of radium per cubic kilometer of the atmosphere. Upon the further assumption that this ionization value is an average for the world, it is computed that to produce this activity of the layer of air surrounding the earth, one kilometer thick, would require at least 600 tons of radium bromide. Next, following the suggestion that the increase in temperature of earth as the center is approached is due to radium, and assuming that the salts of this element are uniformly distributed, this 600 tons of radium would be contained in a layer of the earth only a few meters thick. The result thus reached indicates the possibility of radioactive substances being much more abundant than heretofore suposed, and suggests the further possibility that radioactive phenomena may play an important part in the life of the organic world.—*Electrical Review.*

SAVING TIME IN THE DRAFTING ROOM.

By F. W. SALMON, C. E.

THE man who sits on a high stool before a big table and looks serious a number of hours a day, and very often sharpens his pencil, is not always the man who gets out the most drawings or the best. This was very forcibly impressed on the writer's mind some time ago where there were several changes in the office force, and amongst the new-comers there was one man who told us all of his long and varied experience in every line of work which, as the writer remembers correctly, included air ships and various devices in the use of radium, and of course all such common things as battle ships, dynamos, electric traveling cranes, blast furnaces, gas engines and racing yachts had been constructed in various parts of the world for all the great millionaires, by this young man whose beard was quite short.

Of course we learned the history of this young man by degrees, but we were all very much impressed by the very complete kit of tools that he carried, which was certainly very attractive and seemed to cover about everything that a man could expect to use in a drafting room, and as chance would have it, this young man was put on the same table beside the middle-aged man who did not seem to have anything, and who was continually borrowing everything (except a two-foot rule) from his neighbors. Nevertheless the man without the tools was busy all the time and did get the drawings and tracings made.

Now, the particular incident that I think will prove interesting to the reader happened shortly after dinner, before the engineer had returned, the ch man having come in, looked a seriously and seeing that every busy left the office, when c friend with the large box of tc out to borrow an oil can to oi screws on his bow-pen-compas he had said had got dry and ing. He had been doing mc cussing all the forenoon about office, without an oil can," and around from one to another te what a beautiful silver-plated can had been given him in som name of which I don't remem he always carried with him special grade of watch oil, bu had not thought to bring do office, and that he just wanted ours for a few minutes. Now draftsman always scolds ever mercifully that produces a which the lines appear to have on greasy cloth, so we are all afraid of everything greasy, a reason used to wear high wh and long white cuffs, and ke way from everything that l machinery, so nobody had an o our young friend with the lar of small tools commenced his grimage around the office, tel one of us what a miserable, less, worthless, good-for-not bad, bum-office ours was, bec not have an oil can. After thi gone through with, our frier any tools called the other ma asked him what was the matter he wanted, and after receivir

ition he told him he would fix his uments, so our young friend seemed once jump to the conclusion that he d now get repaid for all the lending he had done. So taking all the small over to the other man, he watched rub the point of a soft black lead pen- n the screw of each instrument and run it back and forth, when it ap- ed to be better lubricated than it d have been with oil, and since that we have always taught the new- ers to rub a soft pencil on the screws heir instruments with very satisfac- results.—*The Canadian Engineer.*

The Lay-out of Piping.

often in the illustrations used to different ways of piping on part of drawing indicates the location of a n or other means of closing up the nections.

et us take for instance a sketch which ared in "*Graphite*" by a well known neer.

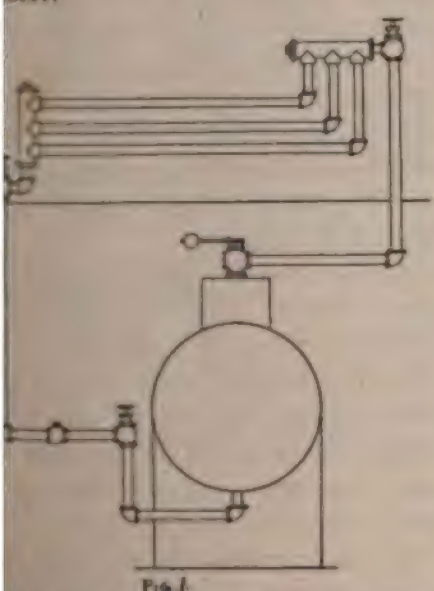


Fig. I.

he sketch was given to show the man- of connecting a heating coil to a ler and it may be understood that the fellow who would put in the work would have sense enough to provide for closing up the system, and in most cases there would be used union valves to the coil.

Still the point we wish to make is that our sketches should be as complete as possible to overcome the ignorance of the simple.

Start Fight on Plumbing School.

The United Association of Journeymen Plumbers, Gas & Steam Fitters' Local Union is condemning the claims of a certain trade school which advertises it can turn out a finished journeyman plumber and fitter in three months and fit him to earn from $5.00 to $8.00 per day.

The claim which particularly incenses the Chicago journeymen is the one which assures the graduates of membership in the union for payment of an additional fee of $25.00. Needless to say the Union referred to is not the United Association, but a so-called National League of Journeymen Plumbers made up of members who seceded from the New York local of the United Association. The league has apparently loaned its name to the school in question for advertising purposes.

The position of the United Association on the subject of apprentices is well established and admitting trade school graduates without further apprenticeship is not a part of their program.

The tallest people are the Polynesians, that island race which include the natives of Samoa, New Zealand, The Marguesas and Hawaii. The average man among them stands five feet ten inches. The shortest people are the bushmen of Africa, whose height is but five feet, four inches.

READING DRAWINGS.

By Prof. A. Edward Rhodes.

PART II.

DIMENSION is extent in any one direction. Dimension is only in one direction, as of a line, is known as length. When there are two dimensions, as of any surface, the two dimensions are called length and breadth. When there are three dimensions, as of a solid, the longest dimension is known as length, the next is known as breadth, and the shortest is known as thickness Thickness, however, always expresses solidity, and is never used to express the third dimension of a hollow object. The terms here given are applied to solids (objects) without refernce to position. A solid, when considered with regard to both dimension and position, has three dimensions, one vertical, and two horizontal dimensions. The vertical dimension is known as height, and the horizontal dimensions are designated by width—width from left to right, and width from back to front. When the vertical dimension is less than the shorter of the horizontal dimensions, it is sometimes known as thickness. It is better, however, as a rule, to adhere to the terms height, width from left to right, and width from front to back when speaking of objects placed in a definite position.

When a solid is simple and regular, the facts of its form can be shown in two views:—the front view showing height, and width from left to right, and the top view showing width from front to back, and from left to right. These views should be placed in the same relation to each other that they have in the object; that is to say, the top view should be placed above the front view, etc.

In working drawings, visible edges are represented by heavy lines, thus: ——, invisible edges are represented by heavy broken lines, thus: — — — —, construction and dimension lines are made light and broken, dimension lines have arrow heads whose points indicate limit of dimension, centre lines are made light and broken. Dimension, construction, and centre lines are sometimes finished in red ink to distinguish them more readily from the edges of the object represented.

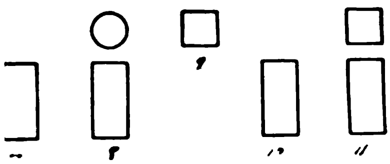
A solid having all its edges parallel to the planes of projection may be represented by lines equal in length to the edges they represent. Illustration,—A cylinder supported in space with its axis perpendicular to the horizontal plane of projection, has for its top view a circle, figure 6, and for its front view an oblong, figure 7, placed directly under the top view, as in figure 8.

Again, a square prism supported in space with its top face parallel to the horizontal plane of projection, and its front face parallel to the vertical plane of projection, has for its top view a square, figure 9, and for its front view an oblong, figure 10, placed directly under the top view, as in figure 11.

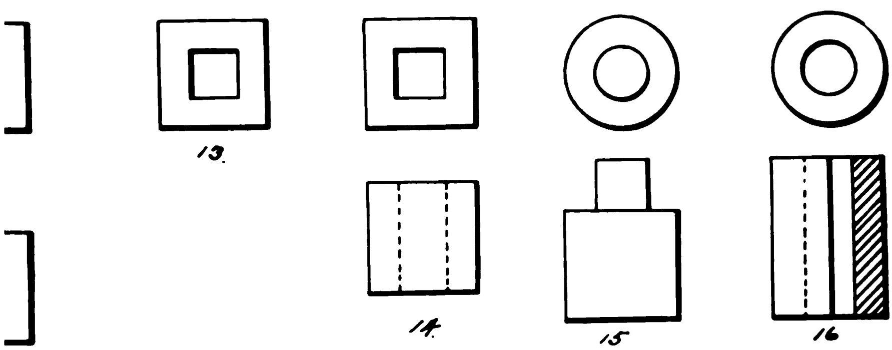
In working drawings the edges only of the object represented are shown, rather than a shaded or picture surface of the object.

Line shading aids materially in reading

drawings, as it frequently ena- reader to decide which face of :t in the higher or lower plane referring to another view.



ations—Figure 12 represents a block having a smaller square sting on it. Figure 13 represents



of a square block having a square 'ough it as hown by figure 14. 15 shows a smaller cylinder rest- a larger cylinder. Figure 16 . cylinder having a hole through ıwise. Half of the front view is n section, this is often done as it ıe interior, as well as the exterior :tion of the object.

ɔrking drawing is not complete ı gives every fact that a workman nt to know at any time during the :tion of the object. Therefore, a working drawing has, in addition to lines representing the object, dimension lines, dimensions, and memoranda.

Reading a working drawing is interpreting the meaning of a given arrangement of lines, dimensions, and memoranda. In other words it consists of the power to imagine the shape and proportions of the solid represented by the drawing.

The best way (I know) to learn to read working drawings, is by making working drawings, both by drawing from the object, and by copying from drawings made by others.

When an object, as a machine, is composed of several parts, think of the several parts as individual objects; then as a complete machine. Sketch the several parts of a complete machine, "working up" the views from an assembly drawing, write a description of an object from a drawing of it.

Success is the result of constant endeavor.

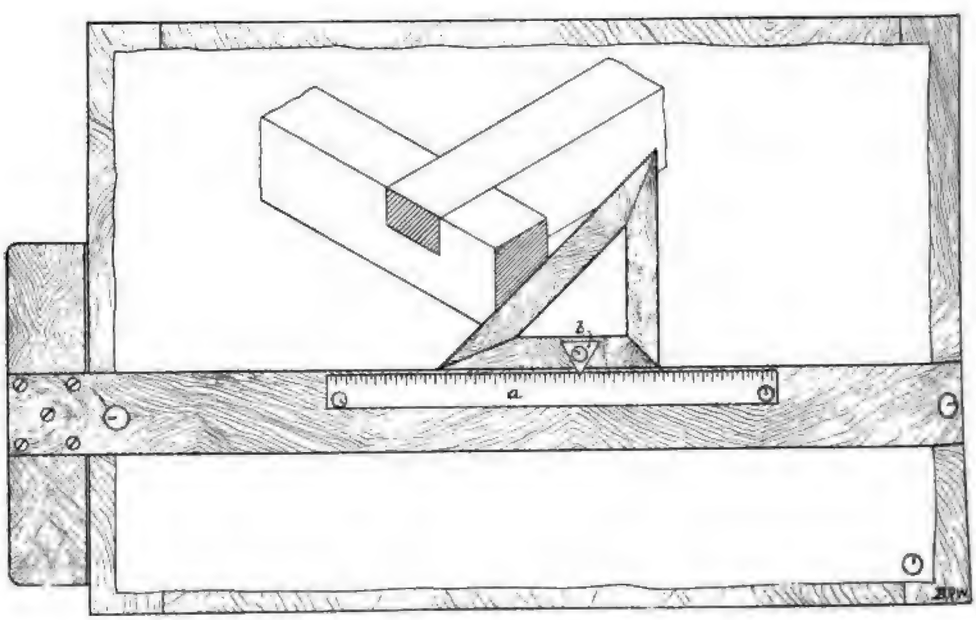
SECTION LINER.

THERE is no excuse for spoiling good drawings with bad section lining when a simple and at the same time, very accurate little device for doing the lining neatly, can be secured for twenty cents.

The appearance of section lining depends entirely upon the even spacing of the lines. In large work, where the lines are far apart, the spacing can be gauged quite accurately with the eye, but in very small work the slightest difference in spacing is glaringly visible. Nine times out of ten, when the draftsman attempts such work with only his eye to guide him, he will turn out a bad job.

While section liners are absolutely necessary in some cases, the student is not always prepared to stand the expense of purchasing one. If he will follow the directions given herein he will soon have an accurate section liner and will not feel the expense.

First purchase a paper scale, costing twenty cents. These scales are printed on bristol board and are usually one and three-quarter inches wide and nineteen inches long. They can be had with any kind of division, either engineers or architects, but the scale for this purpose is the engineer's, divided twenty parts to the inch.



By prolonging every other division mark, by drawing a light line a little beyond the printed lines, we secure a scale divided twenty parts to the inch and also ten parts to the inch. These divisions will be found to answer all purposes.

The scale should now be cut in half, and one half put away for future use. Trim up the ends of the other half so

begins and ends with one of the n lines, and be sure to save the ends you cut off.

now want three of the smallest tacks to be had—three sixteenths inch in diameter. If these cannot ured, larger tacks will do if the are filed off to about three thirty-s of an inch.

h two of these tacks, fasten the scale to the blade of the T-square, wn in the drawing at (a). Be sure he tacks do not go through the re blade and that the points are thick that they split it.

m the piece of blank board cut from d of the scale cut a small triangular (b) and fasten it to the forty-five triangle, as shown in the drawing, the third small tack.

This completes the section liner. Its use should be clear from the drawing. To permit the free use of both hands the T-square can be fastened to the drawing board by pushing a long pointed thumb tack through each end as shown. If done carefully the tacks will not split the blade.

Section lines at an angle of either 90°, 45°, 60°, or 30° may be made by shifting the indicator point b. When the triangle is not in use for section lining the indicator point may be turned up out of the way.

The scale may be slid along the blade of the T-square so as to bring it to any position, or the entire scale may be fastened to the blade. If this is done the scale should be held in place by four tacks instead of two.

CURRENT TOPICS.

hanically educated men are in de- not only as draftsmen, foremen perintendents, but in the illustra- d advertising departments of trade and as traveling salesmen for acturing concerns.

some one work up a design for a mall compressor or section fan di- onnected to a motor for sucking rough a hose from all parts of the Pipes could be carred like gas o different parts of the house and attached and by means of push the motor could be started. The plant should be small and at a price reach of the ordinary house r.

A very convenient device could be made by attaching a pump to the front post of a bicycle and to be operated by one-half of the handle-bar as a crank or lever.

One-half of the handle bar could be solid with the post while the other could be arranged with thumb screw and spring so that in loosening, it would work free of the teeth or ratchet face needed to hold it rigid while the wheel is being ridden. A small metal tube could be secured to a point on the frame that would be conveniently reached by a small tube which the rider could carry in his pocket.

Some of the railroads are lowering the position of the headlights so to give bet-

ter distribution of the rays of light on the track. A position selcted is directly in front of the boiler and practically 18 inches lower than on the old types.

The firm of Fouts and Hull, patent attorneys, 412 The Arcade, Cleveland, Ohio, has been changed to Bates, Fouts & Hull, with offices at 1028 Society for Savings Bldg. Mr. Bates comes to the firm with a wide experience in this class of work, and was formerly member of the firm of Thurston & Bates.

The largest raindrops are about one-fifth of an inch in diameter. In order to determine the size the rain is allowed to fall into a thick layer of flour, each drop forming a pellet of dough, and these pellets are compared with dough pellets obtained from drops of known size delivered on the flour by artificial means.

At sea level water boils at a temperature of 212 degrees, but at a higher elevation it boils at a lower temperature. At the hospital of St. Bernard, in Switzerland, it is 200 degrees, 8,600 feet above sea level. In the Himalayas it has been found to boil at 180 degrees.

But few people know the great strength of the paper which, when properly printed and stamped, becomes money.

A single Treasury note measures three and one-eighth inches wide by seven and one-fourth inches long, and will suspend forty-one pounds lengthwise and ninety-one pounds crosswise. Notes are printed four to a sheet. A sheet will suspend one hundred and eight pounds lengthwise and one hundred and seventy-seven pounds crosswise.

The remarkable strength of a United States Treasury note may thus be seen at a glance.

More than 17,000,000 postage stamps are used in this country every day in the year.

Dr. G. N. Brink, deputy superintendent general of education of the Philippines, says that the islands have 860 American teachers, 5,000 native teachers and more than 50,000 native pupils, like Japanese in intellectual readiness and keenness.

For gear cases and similar castings for automobile engines, where lightness is one of the first considerations, an alloy, composed of aluminum 82, zinc 15 and copper 3 parts, is recommended. If greater rigidity is required the percentage of copper may be slightly increased.

Civil Service Examination.

The U. S. Civil Service Commission announces an examination March 21, 1906, at a large number of places to secure a proper person to fill the vacancy in the position of topographical draftsman in the postoffice department at $900 per annum. In making application to the U. S. Civil Service Commission, Washington, D. C., ask for Form No. 1312, and state that it is for the above position.

Pure Water Helps Engines.

People may be willing to drink impure water, but they are not willing to offer it to their locomotives. Purified water results in sure economy and excellent business returns from the viewpoint of the locomotive operations, and also relieves the shops and roundhouses of a vast amount of work, which increases with the weight of locomotives and the increased demand upon them. Although the first cost is large, returns are so prompt and so liberal that to do without water purification is pronounced folly.

BROWNING'S
INDUSTRIAL MAGAZINE.

VOL. V APRIL, 1906. NO. 4

Overhead Trackage Trolleys and Hoists.

FOR handling heavy material, the status of the electric crane is well established, the range extending from 5 or 6 tons to carrying a complete 100-ton locomotive. For handling smaller weights the auxiliary hoists is called into use, especially at points inaccessible to the larger crane. There has been developed it is not to be wondered at that this means of hoisting and conveying has become an indispensable feature of large manufacturing establishments and power stations.

Several features must be considered in the construction of overhead trackage systems:

Fig. 1—Plain Trolley.

a smaller class of apparatus possessing the general qualities of the larger and oftentimes covering as large a territory. We refer to the system of traveling trolleys, which with a suitable arrangement of tracks, gives a flexibility and range of operations which is ideal. With such speed and facility of control,

1st. Means of support.
2nd. Type of track.
3rd. Kind of power.
4th. Distance traveled, although the last mentioned feature of course influences all the others. The most common type of track is the I beam section and the trolleys made, as shown in Fig.

1. To this trolley is attached an ordinary chain hoist, being hand power in hoisting and propelling. The problem of strength in a case of this kind is practically one of a beam loaded in the center and the support being secure enough to carry the beam and the load. To lift the load and transmit it along the track has been accomplished by several styles of hoists, all of which have practically been electrically driven.

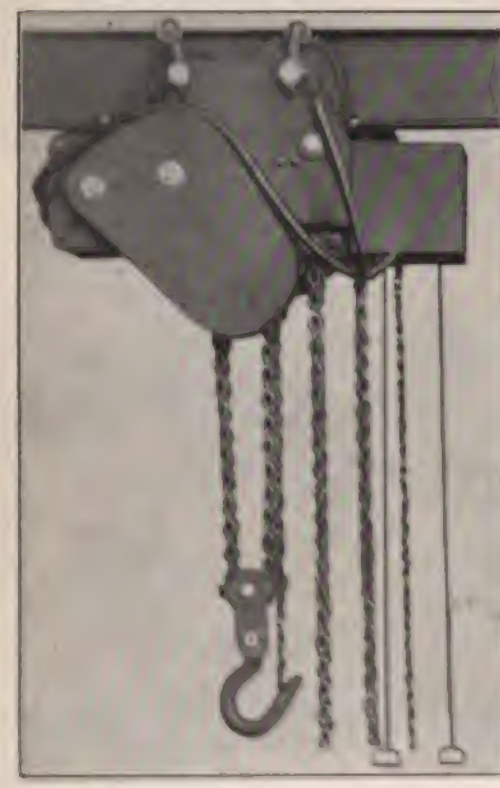


Fig. 3.

The Coburn Trolley & Track Co., Holyoke, Mass., have for a number of years been making a track of rolled steel of a box section and suiting their trolley wheels to the inside grooves. This mode affords a very stiff beam and less damage to the spreading and falling off, as would be the case with the I beam overloaded.

The arrangement of track, including the switches, crossovers, etc., must necessarily be left to the ingenuity of the designer. The necessity and convenience should then be determined. A type of electric trolleys and hoists combined is shown in Fig. 3, made by the Northern Engineering Works, Detroit, Mich.,

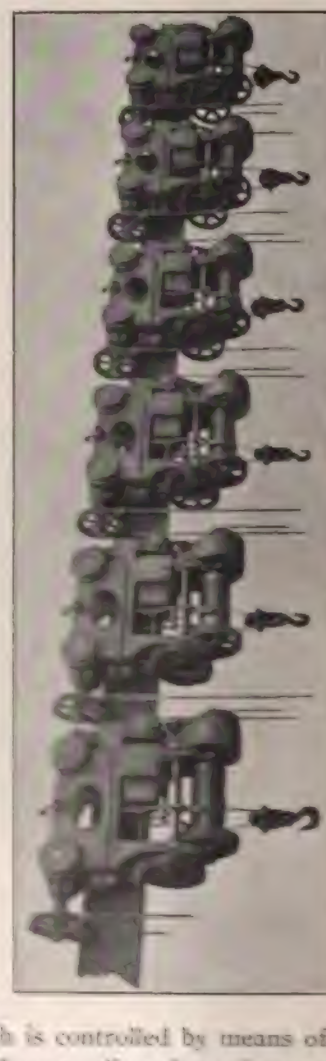


Fig. 4.

which is controlled by means of a small handle extending down in reach of an operator on the floor.

These have a hoisting capacity of 10 to 15 feet per minute, the motors being of the direct current type with the gears encased as shown.

Fig. 4 shows a group of 6 hoists built for open hearth furnace service with extra high lift.

These trolleys have hoists of special construction and were designed to run between the overhead box crane runway girders which support the heavy crane over the converter. These hoists travel by hand gear as the travel is very short; all motions are controlled from the lower floor at a hoisting speed of from 20 to 30 feet per minute. They work with an automatic lift, automatic stop, automatic brake, and both motors and controllers are supplied with asbestos screens for protecting them from the heat below. The illustration shows one side rail, the other being removed for better observation.

Fig. 5 shows operations of a hoist of this form, fitted with two motors, one for hoisting and the other for traveling, having a lifting capacity of three tons at a speed of 15 to 40 feet per minute, travel speed 250 to 300 feet per minute. The motors used are of the direct current type and the controllers of the face plate type; an automatic brake suspending the load at any point, automatic cut-off preventing the hook from rising in-

Fig. 5

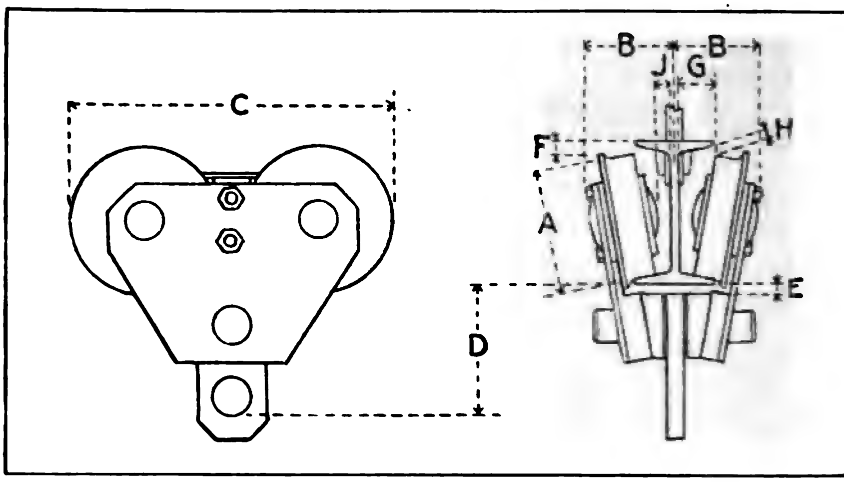
to the trolley.

Where floor control is not suitable, this trolley has been built with a cab for operator. This construction shows I beams style of track, switches, turntables, etc., for changing the direction of the trolley to various parts of the works.

In the transfer of long material, such as rails and beams, self-propelling w...

leys with chain hoist would be attached at one end, and a simple trolley, as Fig. 1, with a chain hoist could be attached at the other, the two trolleys near the track being connected by means of rod or chain.

When a platform was needed to carry sacks or loose material of any kind, the rod or chain connection could be applied.



CLEARANCE DIMENSIONS BROWN PLAIN TROLLEYS.

Capacity in Tons.	A	B	C	D	E	F	G	H	J
½	4"	3¼"	10¼"	4⅝"	11/16"	9/16"	1½"	9/16"	5/16"
1	5"	3¾"	1'-1"	5 13/16"	7/16"	½"	1⅝"	½"	7/16"
1½	6"	4¼"	1'-3¾"	6 15/16"	½"	½"	1¾"	⅝"	5/16"
2	7"	4⅜"	1'-5¼"	7 5/16"	7/16"	½"	2"	⅝"	⅝"
3	8"	5 5/16"	1'-8¼"	8 11/16"	½"	⅝"	2 3/16"	⅝"	½"
4	9"	5 9/16"	1'-10¼"	8⅝"	3/16"	⅝"	2 7/16"	½"	9/16"
5	10½"	6"	2'-1¾"	9⅝"	7/16"	¾"	2⅝"	⅝"	¾"
6	13"	6 11/16"	2'-7"	10⅝"	⅝"	1 5/16"	3⅝"	1¼"	1 3/16"
8	18"	8½"	3'-6"	1'-1¼"	1"	1"	4"	1¼"	½"
10	18"	9"	3'-6"	1'-1¼"	1"	5"	4¾"	5"	¾"

Brown trolleys are made by Yale & Towne Co., New York.

SPECIAL APPLICATION OF THE ELECTRIC MAGNET.

THE uses and advantages of the electric magnet for shop and yard has been quite extensively discussed, but magnets for handling material can only be used within reach of the necessary current.

Overhead cranes near the shop that are electrically driven are also used to handle a lifting magnet, but to carry it around the yard, go into every nook and corner where railway tracks can be laid calls for an expensive outlay for wire alone. To offset this, a small generator plant of a twin engine and dynamo is being installed by many firms who wish to use a magnet. This is applicable to portable and self propelling cranes of the locomotive type also.

Steam is at hand for the engines and the dynamo gives the needed current, allowing the operator free opportunity to control the crane and magnet. The generator set shown attached to the crane in the illustration is made up of the Westinghouse Twin Engine with cylinders 4" diameter and 4¼" in stroke and a dynamo of 5 H.P. at 110 volts.

The power necessary for a magnet 32 inches, weighing complete with chains and eyebolts about 1,700 pounds, requires about 15½ amperes at 220 volts, and will handle an average of from eight to nine ordinary machine cast pigs or similar quantity of other material.

The cost, including interest on the investment, is about 6½c per hour to operate continuously.

The danger from lifting in this manner is not great, since so few accidents have occurred with magnets as compared with the slipping and breaking of hooks and chains.

As a provision of safety, it is recommended that an independent line be run from the generator to the point of application, this line being heavily fused and connected to the generator in advance of the main and feeder circuit breakers, so that the opening of these through over-load will not interrupt the current supply to the magnet.

The case is a heavy casting made from such a grade of steel that when the current of the energized coil is open, the magnet drops its load instantly, so no time is lost.

The striking qualities of the magnet was shown not long ago when a pair of wheels were raised to the height of the crane, the load was released for a drop of 10 feet and suddenly checked by the brake. Even in this sudden jar the magnet retained its load, which was then lowered to the ground.

These lifting magnets are suitable for handling pig iron and steel, or scrap iron, bolts, billets, slabs, cold ingots, pipes, sheets, rails or, in fact, anything of odd shape in quantities, even under special conditions. Several firms make a specialty of designing and constructing these lifting magnets, and one style will average 500 lbs. of pig iron per lift, and the larger size from 1,100 to 1,400 pounds. In moving small materials, the ease of handling many pieces is a noticeable feature.

Such stuff as iron and steel trimmings or borings, bolts, rivets and punchings, which are usually so hard to manipulate, are handled at the rate of from 600 to 1,200 pounds per lift by the larger type of magnets, and are particularly suitable

for being removed by this wonderful application of the electric current with a lifting magnet.

All the heavy work is done by the electric magnet and crane, and this explains how only a single workman in a number of cases is required, and he only to manipulate the machine. Substitution of tongs or a grab bucket to a crane of this type would secure a fine labor-saving and material handling machine.

GIGANTIC STEEL INGOT.

LONDON, March 3. — The largest steel ingot that had ever been made has just been cast at the Manchester works, Openshaw, of Sir W. C. Armstrong, Whitworth & Co. The ingot, weighing 120 tons, was cast on the well known Whitworth system of fluid pressure.

That is, that 120 tons of molten steel were poured out from the melting furnaces into a huge ingot mold box, itself weighing 180 tons. On the mold box being filled with molten steel, the whole was pushed under a monster hydraulic press, having a hydraulic ram 6 feet in diameter, with a hydraulic working pressure of three tons per square inch. This press is, therefore, capable of exerting a total actual pressure of 12,000 tons.

The huge ingot referred to was, while in a molten condition, subjected to this enormous pressure, the action of this process being to make the ingot homogeneous and sound throughout and free from cracks and fissures. The ingot just cast is for the manufacture of the low pressure turbine motors for the 70,000-horsepower Cunard turbine liners.

PIPE BENDS.

Their Application, Flexibility and Comparative Cost.

A MARKED feature in the piping design of a modern steam plant is the free use of bent pipe. Until very recently bends were not utilized in this country to any great extent, although in European practice they were freely employed.

No doubt the high prices of fittings in Great Britain and on the Continent forced engineers to turn to bends more than was necessary in America, but this necessity made for better pipe lines, as American engineers have recently realized, with the result that bent pipe is now utilized as freely here as abroad.

Bends offer many advantages to the mechanical engineer in the way of making stronger lines, reducing friction, reducing the number of joints and compensating for expansion, and contrary to general belief do not add to the cost; in fact, in many cases the cost is reduced.

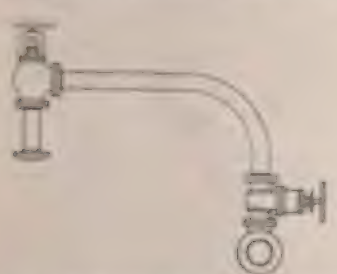


Fig. 1. Boiler and header connection.

Some of the more common forms of pipe bends and their application to steam lines are shown in the following drawings.

So far as we can ascertain, no thorough attempt has ever been made to determine the maximum amount of expansion which a U loop, or quarter bend, would take up in a straight run of pipe having both ends anchored.

Experiments in this direction would have to cover a wide range of sizes and materials, for flexibility increases with the radius and decreases with the diameter. It is also greater with full weight than extra strong pipe. The practical limit would also be governed by the strength of the material in the flanges or fittings to which the bends were bolted.

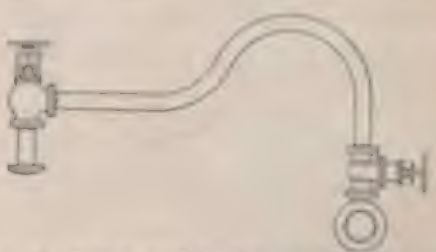


Fig. 2 Boiler and header connection when header is higher than in Fig. 1.

As far as the radii of pipe bends is concerned, local conditions in the average power plant prevent extremes in the way of very long bends. We have adopted five diameters of the pipe as a standard radius, which will come nearer than any other to suiting average requirements, and at the same time produce

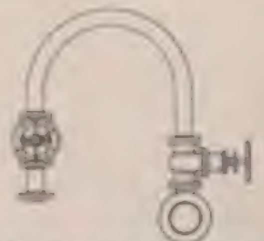


Fig. 3. Boiler and header connection with a U bend.

a symmetrical article. Bends shorter than this can be made, but they are extremely stiff, tend to buckle in bending, and the metal in the outer wall is stretched beyond a desirable point. Very short bends must be made of extra strong pipe if a safe thickness of metal is to be maintained, and when it is necessary to use the minimum radius to which extra

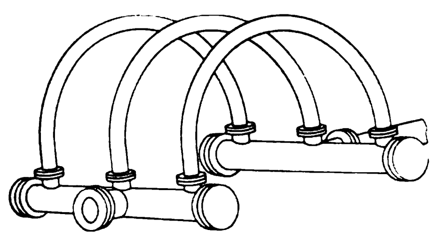


Fig. 4. Battery of three 8-inch U bends connected to headers and placed in 14-inch main steam line to take care of expansion and contraction. This combination is preferable to a U bend the full size of the pipe because of its greater flexibility.

strong pipe can be bent, such bends should be considered as fittings only, and not taken into account when making provision for expansion.

During the past summer we made a few experiments with 8-inch U and quarter bends to ascertain the amount of ex-

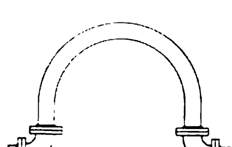


Fig. 5. U bend located in a straight run to allow for expansion.

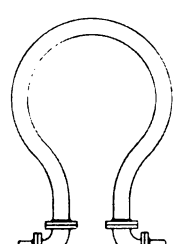


Fig. 6. Modification of Fig. 5 for limited center to center spaces.

pansion they would take up, but press of business prevented us from carrying out the idea as fully as we intended.

For the first test we bolted together a run of 8-inch pipe, as shown in Fig. 14. The bend was made of steel pipe .32 thick, weighing 28 lbs. per foot. with extra heavy cast-iron flanges screwed on and refaced. The elbows were extra heavy cast-iron, and the straight pipe was steel with extra heavy cast-iron flanges screwed on and refaced. The pipe was laid on rollers and anchored at points AA with indicators to detect any movement which might take place at points of anchorage.

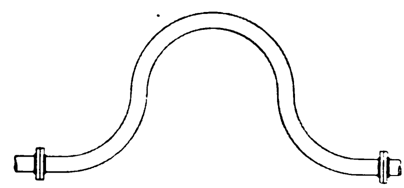


Fig. 7. Expansion loop in straight line. If made in a single piece, can be used only in 8-inch or smaller sizes.

Test No. 1. After the line had been under steam about five minutes and the gauges indicated 80 lbs. pressure, one of the pipe flanges B broke on the north end, one length away from the elbow. The total expansion was 1⅞ inches at the time the break took place. The reason for the break was the lifting of the

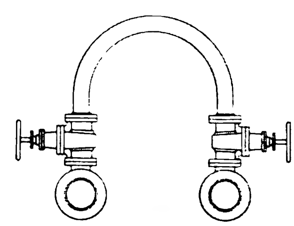


Fig. 8. U bend cross connecting two parallel headers.

pipe, near the U bend, off the rollers, which would naturally throw a severe strain upon the line flanges. Outside temperature, 72 deg.

Test No. 2 was made on the same line. At 50 lbs. pressure the line expanded on the short end ⅞ inch
end 1⅛ inches; tota
lbs. pressure the e
inches on the sh
the long end;

150 lbs. pressure the short end expanded 1⅛ inches and the long end 1⅞ inches; total, 3 inches. At 200 lbs. pressure the short end expanded 1½ inches and the long end 1⅞ inches; total, 3⅜ inches. At 208 lbs. pressure the line flange B again broke, due to the lifting of the line near the bend. As nearly as we could determine, the maximum amount of this lift at the elbows was 1¼ inches.

Fig. 9. Modification of Fig. 8 for special conditions. This form entails some loss in flexibility.

There was no slippage at the anchors and the whole expansion of 3⅜ inches was taken up by the bend. Outside temperature, 78 deg.

TEST NO. 3. Before removing the 8-inch U bend from the line, we thought it would be interesting to ascertain whether a bend of this kind would have a tendency to spread if the anchors were removed. We accordingly took the anchors away and turned in steam at 200 lbs. pressure. The bend spread ⅜ inch,

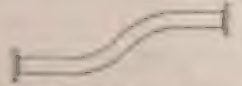


Fig. 10. Offset bend. This is sometimes made compound, that is, offsetting upwards and to one side.

which was about the natural expansion due to the temperature.

After removing the U bend we put a quarter bend at one end of the line, in the manner shown in Fig. 15. The line was rigidly anchored at points AA, and held at point B in such a manner that the pipe could not lift or move laterally. The bend was made of full weight steel pipe .32 thick, with extra heavy cast-iron flanges screwed on and refaced. The line flanges and fittings were also extra heavy cast-iron.

TEST NO. 4. Full Weight Quarter Bend. Steam was turned into the line and when the gauge indicated 80 lbs. and the line had expanded 1⅜ inches, the joint at flange C commenced to leak, the lower part of the flange being forced

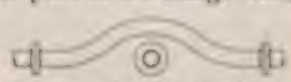


Fig. 11. Crossover bend. Used when necessary to avoid other pipes, pillars, etc.

back slightly on the pipe. This was a remarkable result, and it is difficult to account for the flange not breaking.

TEST NO. 5. Extra Heavy Quarter Bend. The full weight quarter bend was removed and an extra heavy bend of the same dimensions substituted, all other

Fig. 12. 45° bend.

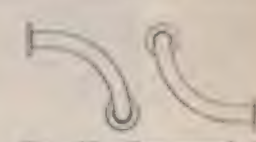


Fig. 13. Compound bend to suit local conditions.

conditions remaining the same. Steam was turned on, and when the line had expanded ⅜ inch, flange C broke at the top. A new flange was put on, and when the expansion was 1⅝ inches the same flange broke at the bottom.

Fig. 14. Diagram of Test No. 1.

Further investigation along this line had to be abandoned for the time, as the space taken up was urgently needed. These few experiments were confined to bends having a radius of five diameters with short tangents. It is reasonable to suppose that longer radii and tangents

would make for greater flexibility.

As an illustration of the comparative cost of full-weight bends and straight pipe and fittings, take a 6-inch connec-

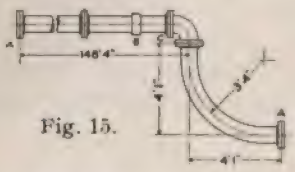


Fig. 15.

tion like that in Fig. 16. The value of a 6-inch full-weight quarter bend as shown, with extra heavy cast-iron flanges and two sets of bolts and gaskets, is approximately $23.50, while the two pieces of pipe, elbow, flanges, and labor, as shown in Fig. 16A, with four sets of bolts and gaskets, would be about $26.

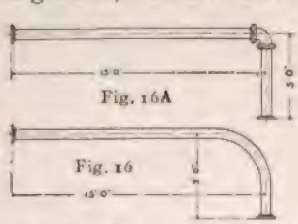


Fig. 16A

Fig. 16

Or, take a 10-inch offset bend, made of full-weight pipe, with extra heavy flanges, as in Fig. 17. The cost of the bend, with two sets of bolts and gaskets, is about $57. The pipe and extra heavy fittings, Fig. 17A, with six sets of bolts and gaskets, would be worth about $76.

An 8-inch U bend with extra heavy flanges, as illustrated in Fig. 18, is worth about $41 with bolts and gaskets. Fig. 18A, with extra heavy fittings, bolts and gaskets, costs approximately $57.

A properly finished bend should bolt in place without strain. If it is necessary to force it into position there will always be a great strain upon the bolts and flanges, the joints will probably leak, and the benefits to be derived through the use of a bend will be partially destroyed.

Method used in testing flexibility of full weight and extra heavy quarter bends.

To make a bend properly requires a shop equipment designed for that par-

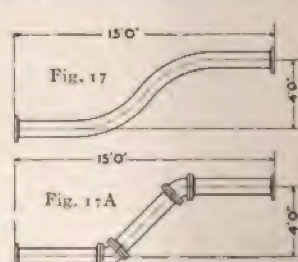
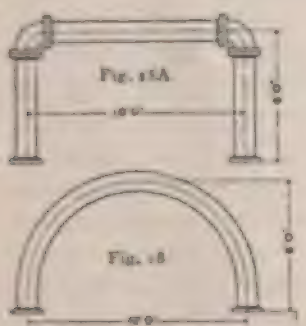


Fig. 17

Fig. 17A

ticular line of work and a great deal of time and care on the part of the workmen. Inferior goods may be turned out

at a low price, but there is a limit beyond which a manufacturer may not go if a high standard is to be maintained at a profit.



It is our aim to hold to the highest possible standard in the product, and charge the lowest price consistent therewith.—*The Valve World.*

Washing Smoke.

In Birmingham, England, experiments are being undertaken to purify the smoke before it goes into the air. As the smoke proceeds from the furnace, it is forced by a powerful fan through a cylinder making 280 revolutions per minute into a tank filled with water. The water is agitated by perforated heaters and this process has the effect of washing the smoke which is then allowed to escape into the atmosphere. This device does away with the usual large chimney, which coupled with the saving of waste produce from the smoke is worth about $50.00 per ton.

Underground Wires.

The expense is not the only objection of the telephone and telegraph companies to putting their wires underground. The underground wire is very much diminished in power of transmission, so that 15 miles of underground circuits in New York cuts down the curent as much as 800 miles of overhead transmission.

Which Is the Long Way?

Much interest has been taken in a question in Ryerson's Monthly with reference to an order received calling for 100 sheets No. 16 x 48 x 96 galvanized, to be rolled the long way to a radius of five feet. Which is the long way?

Some writers admitted that there were several good reasons to be given as to either Fig. 1 or Fig. 2 being the right way, but only one could be right, and that should be understood.

Fig. 1. Fig. 2

Many of the answers were in favor of Fig. 2, because to roll a sheet it was necessary to run it through a machine the long way, this being the greatest dimension between the edges.

If there be any doubt about the way the sheet should be rolled, ask the order clerk for instructions, and in making an order be careful that no mistake can be made.

The Awakening of Manila.

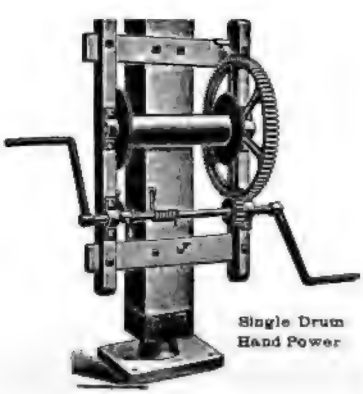
The new electric street railway in Manila, P. I., is doing wonders for the city. It seems to have inspired the citizens to cleanliness and activity. The work of building was carried on exclusively by Filipino laborers, under the direction of American foremen. The Americans soon discovered the native workmen were peculiar. They would not stand scolding, but great patience rendered them fairly active, although it was difficult to keep them working more than four days in a week. They were inclined to believe that three or four days of consecutive labor was quite enough, even at seventy-five cents a day.

PROGRESS OF HOISTING MACHINERY.

By C. C. MAISON, author of "Trigonometry Simplified."

DOUBTLESS many people who look down into the depths of hoisting shafts, or watch the rapid ascent and descent of cages during the busy hours of hoisting at a mine, would hesitate about accepting an invitation to step aboard and make a trip into the underground workings.

These same people probably ride daily in elevators in office buildings and stores without giving the matter a thought; and yet the conditions of operations of some of the "express" elevators in some of the highest sky-scrapers approach those met in mine shafts. Many elevators are, however, intrusted to mere boys to run, while, as a rule, the men



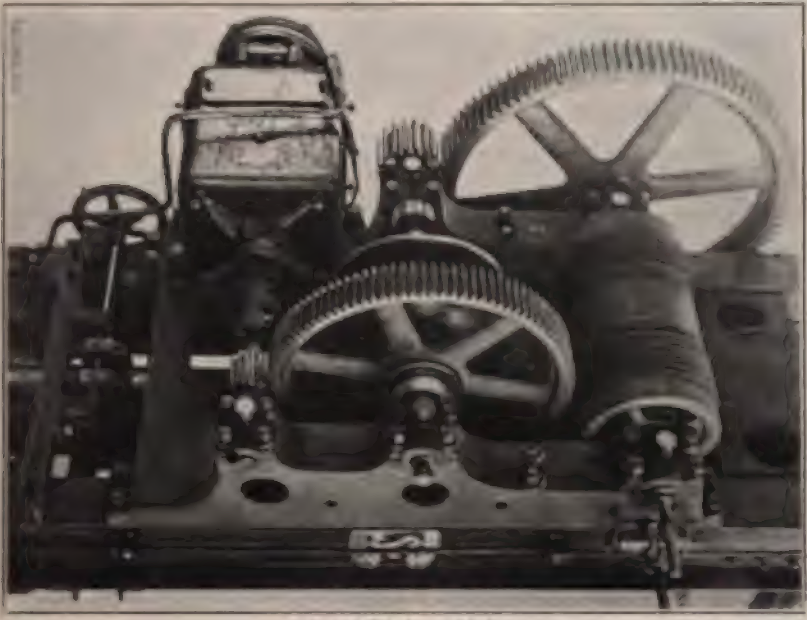
Single Drum
Hand Power

who handle the throttle of hoisting plants are among the most reliable of the employees about the works. Occasionally we read about an accident, such as the recent catastrophe at the Independence Mine in Cripple Creek, Colo., or the Porrance shaft at Wilkes-Barre, Pa. In both of these instances men were being hoisted out of the mine, and through some disarrangement of the mechanism, control of the engine was lost, the cage crashed into the head crane, and then, with its load of human freight, dropped into the shaft hundreds of feet below the surface, causing the distressing loss of life.

When we consider that thousands of men are daily lowered into, and hoisted from, the mines, the infrequency of such accidents is one of the best possible commentaries upon the excellence of the engines used and the skill and care of the hoisting engineman. Such accidents will doubtless be of less frequent occurrence with the improvements constantly being made in hoisting engines and the greater care exercised in the selection of men, and their greater fitness for the position. Some states and countries allow only certificated men to handle such positions, and the system has much to commend it; for intelligence, steadiness and experience are necessary qualifications for those who may be confronted by an emergency and have to do the right thing instantly. The contrast between one of the complicated hoisting engines used in the middle deep shafts of the Lake Superior region (Duluth), or rather the shafts at Johannesburg (South Africa), which are equally deep shafts, and the hand windlass of the prospector or the carrying of the ore to the surface on the backs of peons in Mexico, is very great; and a history of the gradual development of hoisting practice from stage to stage would be most interesting, but space permits of mere mention of the most striking improvements during the last 50 years.

Compressed air forms a convenient and practical method of transmitting power to one or a number of hoisting

ngines, particularly where water is ailable. This method of transmitting wer has until very recently been of w efficiency and consequently wasteful power, and has been attended with uch difficulty from the refrigerative ac- on of compressed air during the ex- aust and cylinder of the engine. Re- nt improvements in compression and e of air have opened up new area of larged and profitable field for com- essed air, of which we have in use any methods of machinery. Advan- wasteful of fuel, and seldom give an average efficiency of over 2 to 5 pounds of water evaporated per pound of fuel. On the other hand, a first class boiler plant at a central station can be made to give efficiency of 8 or 10 pounds of water per pound of coal. A hoisting engine driven by air under these circumstances is ready for instant continuous service at full power and speed, no time being lost in working out the water or in quickening the fire, in case it becomes dull, and no loss of steam from the safety valve,

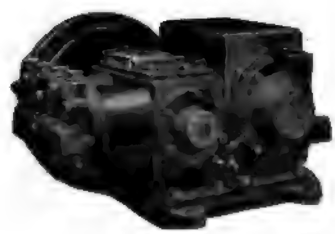


Electric Driven Hoist.

ges of compressed air in hoisting are reatest in cases where one modern, cen- al power, air compressing plant can be sed to operate a number of hoists, hether large or small, located so far part as to require one or more boilers each hoisting station, involving a sup- y of fuel and water for each and the sposal of ashes. A number of such ilers scattered about a mine or quarry rking intermittently, sometimes not lled on for other steam for hours and other times overworked, are very in case of stoppage of the hoist. With a hot fire under the boiler, small boilers give trouble from freezing of connections at night, on Sundays, holidays, and require banking fires or keeping them up at a cost that is large.

There is a tower crane at present employed in Brussels in building construction that is attracting considerable attention, not only among builders of such machinery, but among those engaged in building construction. This crane is of German manufacture and operated by

electricity. The crane is used to remove huge blocks of stone from cars or wagons, and place them in position in the structure. The crane runs upon a track several hundred feet long, with a 12-foot gauge. The extreme height of the crane is 74½ feet, the total to which the hook may be raised is 71½ feet. The crane is designed to carry a load of 15 tons,



Electric Driven Compressor.

while the lifting speed is 10 tons at 15 feet per minute. The crane is operated by three electric motors, one for travelling the crane on the rails, a second for revolving the jib, and the third for raising or lowering the load. And an important feature is that it can be operated on a 4 per cent grade in spite of the small gauge of the track.

Proportioning Air Receivers.

It very often happens that shop foremen are called upon to determine what sized air receiver is best for their purpose, and probably very few such men are qualified to decide this point except by guessing or consulting a catalog. For the benefit of those who may not have a catalog at hand, the following may be of service:

First. Determine the maximum capacity of the compressor per minute in free air. (Piston displacement per minute will do.)

Second. Calculate what volume this air will occupy at the working pressure, and this will be the required volume of the receiver.

This is a very easy calculation to make, as the following example will illustrate:

Suppose the maximum piston displacement of compressor per minute=65 cubic feet.

Working pressure = 80 pounds (gauge). To determine the volume of 65 cubic feet of free air when compressed to 80 pounds pressure, the following formula may be used:

$$V_2 = \frac{14.7V_1}{P_2+14.7}$$

In which V_1=Maximum piston displacement in cubic feet per minute=65.

P_2=Working pressure (gauge)=80 pounds.

V_2=Volume of the air at the higher pressure.

Substituting in this formula we have:

$$V_2 = \frac{14.7\times65}{80+14.7}$$

=10 cubic feet, which would be the volume of a receiver 18 inches in diameter and 6 feet long.

It is therefore possible, by using the above formula, to determine approximately the minimum sized receiver necessary, but in making selection a larger one is preferable. There is no drawback in having the receiver too large; a receiver is seldom too large; in fact most troubles are caused by the receiver being too small to overcome fluctuations in pressure, and by not allowing the air to remain stationary long enough to cool and to deposit part of its moisture.—*W. R. Hulbert, M. E., in Compressed Air.*

Plans are being made, by which the city of New York will draw its water supply from the Catskill mountains. To accomplish this would require an expenditure of $162,000,000, and it would keep an army of men a

Washington's busy a

UNIVERSAL JOINTS.

THE Hooke Universal Coupling is still more used than any other type for securing flexibility between gears and rear axle, and also between engine and change gears, in automobile work, although modifications of the form are appearing which are more compact and fully as powerful.

A flexible-disc positive coupling of a general form, long since used in the propeller shafts of steamships, has been brought into service such as has been more exclusively performed by the Hooke coupling heretofore.

The flexible-disc joint has the advantage of no rubbing of parts over each other, and consequently no need of lubrication, although a somewhat different and neglected necessity in the Hooke coupling.

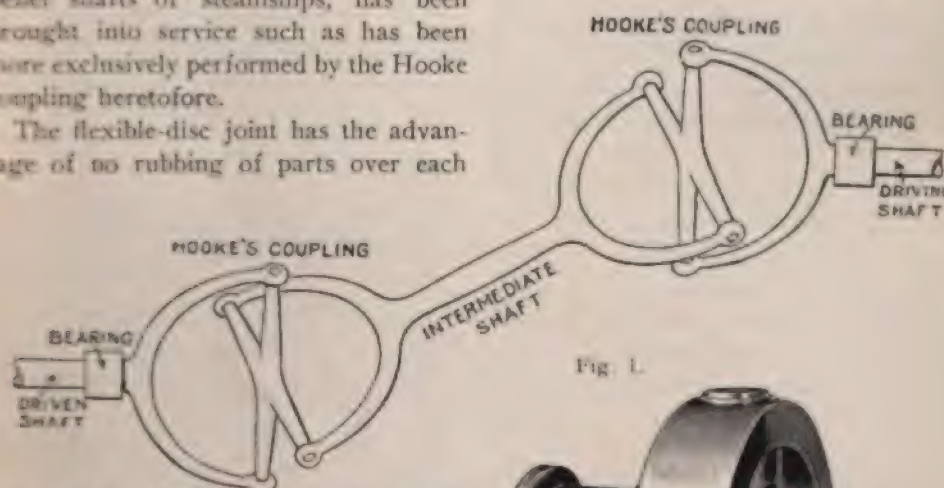


Fig. 1.


Fig. 2.

In machine building the Universal mon and useful feature where flexibility is desired.

The power to be transmitted is never very great in machine work.

The smaller the angle at which a joint is run, the longer it will wear and less power it will absorb.

The working angle of the joints of some makes is purposely limited to 45° on sizes up to 2".

The working angle of 2" and 2½" sizes is limited to 30° from a straight line.


Fig. 3.

Thus, 45° is as much as can be expected of any joint to run, and not over 25 to 30° should be used where a greater angle can be avoided.

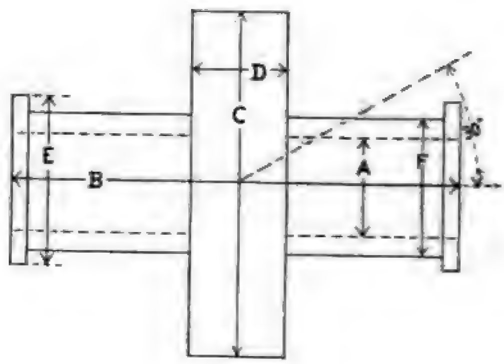
Dimensions of Ring Joints.

No	A	B	C	D	E	F	Weight.
1	1 to 1¼	8	6	1¾	2½	1¾	13 lbs.
2	1⅜ to 1¾	8	6	1¼	3	2¼	15 "
3	1⅞ to 2¼	8	6	1¾	3½	2¾	17 "
4	1½ to 1⅞	10	8	2¼	4	2¾	33 "
5	2 to 2¼	10	8	2¼	4¼	3	35 "
6	2⅜ to 2¾	10	8	2¼	4½	3½	33 "
7	2⅝ to 3¼	10	8	2¼	5	3¼	35 "

In sizes, Fig. 2, varies from ½" to 2½", the bore for shafts 5-16" to 1-11-16", and the largest part 9-16" to 3".

These couplings should be bored to receive the shaft or spindle, and a taper pin driven through both parts.

In Fig. 3 is shown the ring type of joint used for heavier work than in Fig. 2.



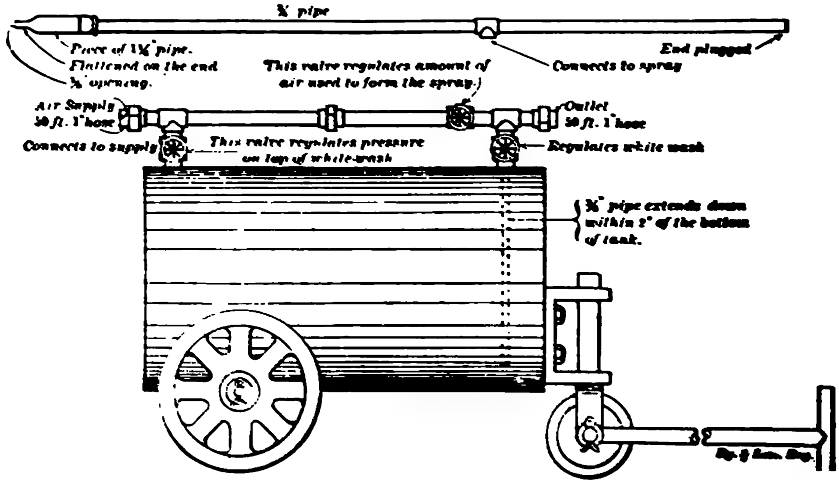
The working angle is purposely limited to 30° from a straight line.

The ring is hollow, having a space for oil which insures positive lubrication.

Figs. 2 and 3 and diagram from Gray & Prior Mach. Co., Hartford, Conn.

A WHITEWASH MACHINE.

A whitewasher operated by compressed air, says a correspondent of *Locomotive Engineering*, accomplishes in two hours an amount of work that would keep one man busy a month. The construction of the machine is fully explained in the illustration.



AN AIR WHITEWASHER.

FRENCH AUTO-MOTOR JET INTERRUPTER.

By FRANK C. PERKINS.

THE accompanying illustrations and drawing show the arrangement and electrical connections of the new French auto-motor Mercury jet interrupter, as designed by G. Gaiffe of Paris, as well as the marble switchboards utilized for working a coil with a current of from 20 to 30 volts, also that designed for a continuous current of 110 volts.

This latest French type of turbine interrupter is said to be so simplified as to entirely dispense with the independent motor, and with it the noise is avoided, as well as the cost of such motors, with their brushes and driving bands. The collectors with their difficulties are also eliminated.

The interrupter is a simplified form of the mercury jet turbine type. A piece of iron of conical form is channeled by a single canal. This canal is obliquely inclined in relation to the vertical axis, in such a way that on rotation the mercury (which, when at rest, fills the lower half of the canal) is, by centrifugal force, driven upwards and outwards through the orifice a, so as to jet against four copper teeth a, connected at intervals with a metal crown c, insulated from the rest of the apparatus. Note that the jet rotates, the crown and teeth are fixed. The width of the copper teeth depends on the voltage—the higher the voltage the narrower the teeth. This method is adopted to secure simplicity in preference to the introduction of a movable rackwork for raising and lowering the teeth.

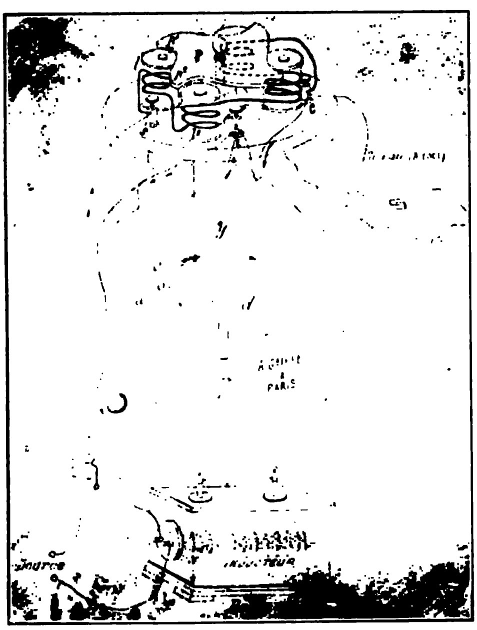
It will be noted that there are no pipes, cog-wheels, or complicated mechanism for pumping or conveying the mercury jet.

The containing vessel is of iron. The illustrations and drawings show the vertical laminæ projecting from the side in such a way as to check the rotary movement of the fluid when the interrupter is in use. The upper border of the wider part of the lamina marks the level to which the vessel should be filled with mercury. The extreme upper limit of the lamina indicates the height to which absolute alcohol should be added, which is the insulating fluid in which the sparking takes place. There must not be water in this alcohol, or electrolysis would result, and the fluid would be no longer insulating.

All mercury interrupters have one disadvantage, sooner or later the mixing of the mercury with the insulating fluid results in the formation of an emulsion, which is not insulating, and new fluid is required. Special precautions have been taken to increase the period of efficient running to the maximum. Hence the form of the rotating parts, the introduction of vertical laminæ to check the

movement of the fluid, and the selection of absolute alcohol as an insulating fluid, because it lasts longer than oil when used with mercury. When a change of fluid becomes necessary, it is most convenient to have a spare retainer, spare mercury, and absolute alcohol ready, so that the operator can continue work without loss of time.

The quantity of mercury required is 5½ kilograms (12 pounds). It would be easy by tapering the bottom of the container to work with less mercury, but the lesser quantity would the sooner require changing.



The driving system, by the direct electrical and mechanical couplings of the motor with the interrupter, constitutes a great advantage over the old types of turbine interrupters. The same interruption cuts the current, both of motor and for coil. The motor is of the magnetic attraction type, with fixed winding and rotating armature.

The windings of the motor are noted at 1 and 1^2.

P is the armature carrying the palettes p^1 and p^2. The number of poles of the motor is equal to the number of teeth A in the crown C, and the armature is so set that, when the jet of mercury makes contact with one of the teeth A, the position is that of maximum magnetic attraction. Interruption takes place a little before the palattes are in position over the core of the electro magnet.

The winding of the electro magnets is connected in series with the primary winding of the X-ray coil. The current is turned on and then the armature of the interrupter is rotated by a smart impulse with the finger, sufficiently vigorous to start the mercury jet. The current then traverses the primary of the coil and also the winding of the electro motor, therefore the interrupter continues to work automatically.

To regulate the number of interruptions, a rheostat is adjusted, which is placed in series with the primary winding of the coil, as shown in drawing. This is the plan recommended for installations on a main current; in this case no separate motor rheostat is necessary. The appearance of the switchboard is shown in illustration.

The Gaiffe-Motor Mercury Jet Interrupter works on continuous current at any voltage from 12 to 250 without change of any part of the interrupter, except the teeth. The lower the voltage, the longer the time contact necessary, therefore the wider the teeth.

The mercury interrupter is very portable, as it can easily be carried from ward to ward, or to such outside cases as doctors are frequently required to attend, and, as there is nothing fragile in its construction, it is admirably adapted for army work.

As the independent motor, with brushes and driving belt used

h, the noise has been reduced to a imum. There is no sound other than t actually produced by the sparking.

If one suddenly turns off the current, the interrupter continues to run for some time in absolute silence.

THE WEIGHT OF A CROWD.

'HE weight of a crowd of people is one of the most important bits of data d by the structural engineer. It uld seem to be one of the most easily ermined, yet it is one on which the horities differ widely, and one which, h few and unfamiliar exceptions, ser- sly understate. Trautwine's hand k recommends:

versity, has made a number of experi- load of 40 lbs. per sq. ft. may be con- vided for as a distributed load for all sidered the maximum load to be pro- floors on which crowds of people may

This might be doubled to allow for vibration in case of ball rooms, drill rooms, gymnasiums, etc.

Mr. Lewis J. Johnson of Harvard Uni-

Fig. 1—181.3 lbs. per sq. ft. (40 men at 163.2 lbs. average, on 36 sq. ft.

"On bridge for turnpike and common ads no probable contingency could wd people to such an extent as to igh more than 80 lbs. per sq. ft. of or; and this may safely be taken as e maximum load on spans of 20 or re feet. To compensate, however, for mpact, we recommend to adopt 100 as the limit for crowds."

Other writers have said "that a live

ments and given photos to show the con- dition of crowding, and amounts per sq. ft. for the weight.

A box or cage 6 ft. sq. was built, the men carefully weighted and arranged in the enclosure.

The photos show the several degrees of compactness of the crowds for the amount of weight per square foot of space.

The conclusions derived from the tests show that loads of 180 lbs. per sq. foot may actually occur in exceptional cases; that 160 lbs. must frequently occur; that 140 lbs. must be common on

Fig. 2—83.7 lbs. per sq. ft. (20 men averaging 150.7 lbs.)

station platforms, in corridors and many other places frequented by throngs of people; that 80 lbs. must be common in social gatherings in private homes.

The conclusion is equally clear that the margin of safety in many existing structures designed for 80 to 100 lbs. per

Fig. 3—41.8 lbs per sq. ft. (10 men averaging 150.6 lbs. on 36 sq. ft.)

sq. ft. (to say nothing of 40 to 45) must be much less than has been supposed. Probably the correct inference is that the experience of many years in many lands has demonstrated that the margin has been sufficient, nevertheless.

Even if that is true, there is no reason why we should remain in the dark about how much a crowd of people actually weigh.

A New Idea in Concrete Steel Construction.

In the discussion on steel-concrete at the Toronto Engineer's Club, (January 25th), it was reported that in experiments made at the testing laboratory of the School of Practical Science, steel, after being stretched beyond its elastic limit, was found to possess the property of taking unto itself another elastic limit beyond which it can be stretched; analogous, we presume, to the phenomenon of the seried overlapping flow limits of ocean tides on the seashore. We understand this theory was accepted by prominent engineers present as a reliable scientific induction. And what is more important, the stretching of structural steel beyond which it can be stretched; analobedded in concrete was actually recommended as good engineering practice. From what we can glean, the objective of this cold treatment of the steel is to equalize the stresses in the dissimilar materials. But what is the price to be paid for this equilibrium of forces? After the limit stretching, is the resilient structural steel, as such, as perfectly adapted for its purpose? We should hesitate to occupy rooms in a sky-scraper built in accordance with this academic drawn-wire theory. Awaiting with interest, formal statement of the case, we betake ourselves to a calm meditation on J. E. Stead's aphorism, which reads thus: "The result of careful experiment is the voice of nature speaking truth, the interpretation of it is the work of fallible humanity."—*The Canadian E*

HELPFUL KNOWLEDGE ABOUT ELECTRICITY.

By Edmund B. Moore,

Author of "Wire and Wireless Telegraphy"

PART VII.

WE have given in the past articles a brief explanation of electrical resistance, also that the unit of this resistance is called the Ohm. That is, the conductor through which the electric current passes tends to resist somewhat the flow of the current. This resistance varies greatly in different conductors, as will be explained later.

A noted scientist, Dr. G. S. Ohm of Berlin, founded an important law by which the current flowing in a circuit may be calculated. This law, which forms the foundation of electrical measurements, is as follows:

"The strength of electric current varies directly as the electomotive force, and inversely as the resistance."

To simplify this we may state the above in the following equation:

$$\text{Current's strength} = \frac{\text{Electromotive force}}{\text{Resistance}}$$

$$\text{or} \qquad C = \frac{E}{R}$$

C=Current's strength, E=E M F and R=Resistance.

The electrical resistance of any conductor depends upon the metal from which it is made, its length, the area of the cross section and its temperature.

The resistance of the Ohm is equal to the resistance of the international ohm. The international ohm is equal to the resistance of a column of pure mercury 106.3 centimeters long, the same to have a uniform cross section of one square millimeter and to contain 14.4521

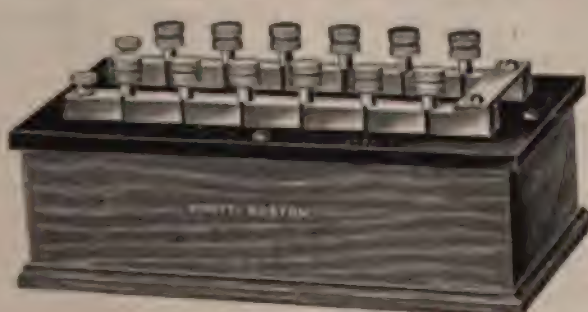


Fig. 26—Resistance Box

grammus of mercury. The temperature of this column should be that of melting ice. This definition of the ohm was given by the Chicago Electrical Congress and is universally adopted as a standard. In the measurement of electrical resistance the column of mercury is substituted by coils of wire, usually German silver, as that is more convenient to handle than the former.

There are a vast number of ways in which the electrical resistance of a con-

ductor may be measured, and it will not be necessary in this general outline to describe only those that are most used in electrical testing, these being, however, the most simple and accurate methods.

The first method which we will take up is perhaps the simplest and the measurements may be taken in as short a space of time as almost any other process. This method is called Measurement by Substitution. The resistance to be measured is connected by a copper wire in series with a galvanometer and a closed circuit battery of moderate strength. The circuit is then closed and the deflection of the needle of the galvanometer carefully observed.

Now the unknown resistance is disconnected from the circuit and a variable known resistance is connected in its place. The circuit is again closed and the deflection of the needle again noted. If the needle does not deflect as before as it presumably will not, the variable resistance should be adjusted, added or cut out as the case may be until the needle comes to rest exactly as in the first case with the unknown resistance. Referring to Ohm's law, the resistance in the first case must be equal to the substituted resistance in the latter coil, because the E M F of the battery remains constant and the needle of the galvanometer shows that the same amount of current passed through its coil each time. Therefore, by Ohm's law the resistance of the total circuit must be equal in both cases. As we know the amount of resistance added in the last case, the unknown resistance will be exactly equal to that.

Generally the known resistance instead of being in separate coils is so arranged and connected in a small box, called a Resistance Box, that the variation may be made at will. The coils of these resistance boxes are made of German silver wire which is usually silk covered. A similar alloy may be used but it must be of a suitable nature that will have a very low conductivity and its resistance must not be altered greatly by the difference of temperature. To avoid self induction in these coils the wire, instead of being wound upon the spools in single, is taken and doubled at the middle of its entire length and then this doubled wire is wound on the spools in even layers. To insure better and more perfect insulation the coils are often dipped individually into melted parafine. These coils are now fastened in rows upon the underside of the top of the instrument. The two wires of each coil respectively are firmly soldered to two brass segments directly over each coil. That is, when the brass blocks are not directly connected by the plugs to one another the entire number of coils will be in series allowing the current to pass through all the coils. To vary the resistance of this set it is so arranged that when necessary each coil may be cut out of circuit or short circuited, each independent of the other. To do this small tapering brass plugs are inserted in especially made holes between the brass blocks, thus throwing out its respective coil and the current instead of passing through the coil is carried across to the next block. If all the plugs are in place there will be no resistance whatever connected in the circuit. The resistance of the brass blocks being extremely low is not noticeable in the least.

To allow a greater range of work the coils of this instrument are usually of different resistance. The coils of a commercial resistance set should consist of tenths, units, tens and hundreds of ohms and often much higher. This

depends upon the work for which the set is to be used.

In using this style of resistance boxes, great care should be taken to have all contact surfaces bright and clean and the final contact firmly made. The brass plugs are provided with a small hard rubber handle which can be firmly grasped so as to force the plugs tightly in their places between the brass blocks. The taper upon the plugs should exactly correspond with the taper in the holes of the blocks and when the plugs are inserted it is desirable to give them a slight twist which will, as before stated, assure a good contact and keep the surface bright and clean. All dirt or grit should be carefully removed from between these brass blocks, for if it be allowed to collect upon the surface very poor connections would be made and the resistance of these joints would naturally be somewhat increased. It should be borne in mind that the resistance should be made as small as possible when all the plugs are home. If the above instructions are followed the resistance of the coils only, when one or more plugs are removed, will be available.

If very accurate measuring is to be done with these variable resistance boxes the temperature must be somewhat taken into consideration. As we stated at the beginning of this present article the resistance varies considerably with the temperature. Most resistance boxes of standard make are fitted with a name plate stating the temperature at which the coils were finally tested in their manufacture, and to have the accurate results from these boxes they should be brought to the stated temperature or if this cannot be done reading should be taken and calculations made in regard to the existing temperature upon the results obtained.

Another very simple method whereby electrical resistance may be accurately measured is by the Fall of Potential Method.

In this method the unknown resistance or the resistance to be measured is connected in series with the ammeter C and a battery of moderate strength B. The voltmeter E is connected in parallel with the resistance. The circuit is closed and the reading of both instruments noted. Then the unknown resistance of R will be equal according to Ohm's Law to the reading of the voltmeter E divided by the reading of the ammeter C. The equation will be as follows: $R = E \div C$. R = Resistance, E, Voltage or E M F and C = Amperes or strength of current. In making this test care should be used not to use a heavy current that will increase the temperature of the wire. If this should result the reading obtained will be somewhat higher than the true resistance of that which is being measured.

A noted English Scientist, Wheatstone, whose name is widely known in connection with electrical engineering invented a method whereby the electrical resistance of any conductor or substance may be very accurately and easily measured. This method is called Wheatstone Bridge Method and the instrument used is called the Wheatstone Bridge after the inventor.

Before taking up the description of this instrument I wish to explain to my readers the principle of Shunt Circuits. These are employed in the Wheatstone Bridge and if carefully explained now the working and operation of the bridge will be much better understood.

If a conductor or wire through which a current passes is divided at any point the electric current upon reaching this division will also divide and if the re-

sistance of each branch is the same, then the current passing through one branch will equal the current flowing through the other, and if there is no inserted resistance in either branch so that there will be no accumulation of electricity anywhere in the complete circuit then the sum of the two divided currents will be equal to the original or individual current. If there be for any reason, noticeable resistance in either branch or the Shunt of the main branch, as it is often called, the current in each will be inversely proportional to the resistance in

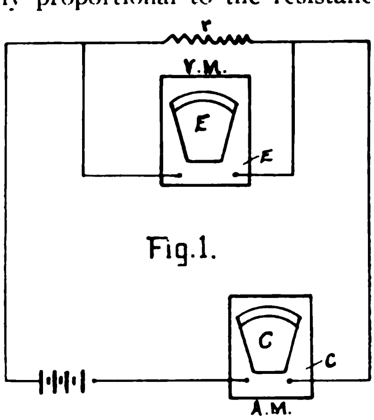


Fig.1.

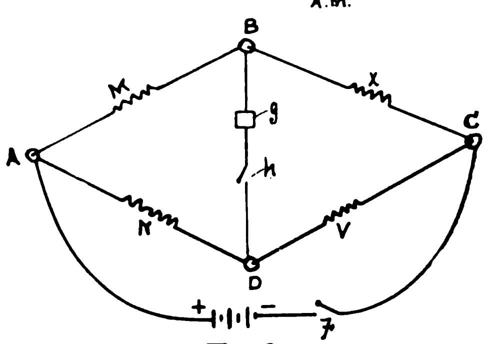


Fig.2.

Diagrams 1 and 2.

the circuits. That is, if in branch A there is twice as much resistance in the circuit as in branch B then when the current divides twice as much will flow through the branch B having one half the least resistance as will flow through the shunt A, which has twice the resistance .branches. We may state the above in a of B. Consequently the amount of current at the point of reunion of the shunt circuits will equal the undivided current minus the sum of the amount lost by overcoming the two resistances in the simple form by saying that ***in a shunted circuit the individual current of its respective shunt varies inversely as the resistance through which it passes.*** Consequently in accordance with Ohm's Law ***if the sum of the resistance in each shunt circuit are equal, then the current at any opposite equal point of the two shunts will be equal, providing the source of E M F remains constant and the fall of potential along the conductor is directly proportional to the resistance through which it passes.*** The above theories are used in measuring resistances by the use of the Wheatstone Bridge and this may be more clearly understood by referring to diagrams here reproduced.

This consists of four branches M, N, X, and V. A suitable electric battery of moderate strength is connected at the points a and C. The arms M and N form a shunt of the circuit of the battery from the point A. M, N and V are known resistances connected into the circuit as shown. The resistance V is a variable resistance of wide range. Connected in parallel with the two shunt circuits at the points B and D is the galvanometer G with a key (h) for opening and closing the circuit. The unknown resistance to be measured is connected at X. The contact key F in the battery circuit being closed, the current will flow to the point A and then will divide, part taking the course A, B, C and part A, D. C. The difference in potential at the points B and D will generally, upon the closing of the circuit, not be equal but the fall of potential between the points A and C must be the same in amount as through the known resistance

M and X, as through N and V.

As before stated, the potential at B and D will not generally be the same and upon closing the circuit of the galvanometer G by contact key h a current will flow across from B to D through the galvanometer, as will be indicated by the deflection of the needle or if a Thompson's mirror galvanometer is used by the deflection of the light upon the graduated scale. If the current does flow upon closing the key from B to D we know that there must be a difference of potential between the two points. It is always necessary in the production of an electric current to have a difference of potential. Now if there is a difference of potential between B and D the fall of potential in the resistance M and N and X and V is not proportional. It is necessary, however, before we can calculate the resistance of X, which is being measured, to have this fall of potential in the branch circuits M and N and X and V proportional. When this has been accomplished upon closing the key h no current will flow through the galvanometer from B to D.

To obtain this result or a balance in the two circuits, we adjust the variable resistance V increasing or decreasing as the case may be until the desired balance has been obtained. This will be shown by the galvanometer needle remaining stationary when the key h is depressed. Under these circumstances the balance being obtained, the ratio of the known resistance M to N will be exactly the same as the unknown resistance X is to be the known variable resistance V. This may be expressed by the equation $\frac{M}{N} = \frac{X}{V}$. The resistances, M, N and V are known. Then the fourth or unknown resistance X may be found $X = \frac{M}{N} \times V$. Supposing the known resistance to be M = 4 ohms, N = 2 ohms and the resistances varies so that V is equal to 5 ohms then by sustituting:

$$\frac{4\,(M)}{2\,(N)} = \frac{X}{5\,(V)} \text{ or } X = \frac{4\,(M)}{2\,(N)} \times 5\,(V) \quad X = 10 \text{ Ohms.}$$

An instrument wherein the principle of Wheatstone's Bridge is carried out is made up in a form which is very convenient for laboratory and experimental work. This is called the slide wire bridge and a good idea may be obtained from one of the accompanying illustrations "Wheatstone's Bridge Testing Set."

Fig. 29—Wheatstone Slide Wire Bridge (Resistance Box and Galvanometer)

In this instrument the two arms X and X are substituted for a strip of German silver wire of comparatively high resistance and of a uniform cross section. This wire is stretched between two brass strips having practically no noticeable resistance. At the ends of these strips are placed binding posts for making connections. Opposite and parallel to this wire are placed three separate brass strips each being provided with three binding posts, one at each end and one in the middle. The two outside strips which are connected with one end of the German silver wire are provided each with two binding posts at the opposite end from that at which the connections with the wire are made. The known resistance M is connected at the end binding post of the middle and left hand strip, thus forming the shunt M in the diagram. The unknown resistance or the resistance to be measured is connected with the end binding post of the middle and right hand strip thus forming the shunt X as in the diagram. The bat[illegible]

[illegible]

in length and placed over a graduated scale which is equally divided into one thousand parts. As we have explained a balance must be obtained between the points corresponding to B and D before the unknown resistance can be found. By moving the slider over the wire a certain point will be reached where no current will flow through the galvanometer and when this has been found the points B and D are at the same potential. So, there will be the same fall of potential between the known resistance and the left section of the silver wire from the point where the slider is placed to obtain the balance as through the unknown resistance being measured and the remainder of the wire or that at the right of the slider. The unknown resistance may be found by the following as in the first case. Unknown resistance =

$$\frac{\text{Length of wire at right}}{\text{Length of wire at left}} \times \text{known resistance.}$$

It is not necessary to know the resistance [illegible] of the German silver wire because [illegible] itself be of uniform cross section [illegible] the resistance will be proportional to its length and this [illegible] be expressed by the reading [illegible] millimeters.

[illegible] of bridge care [illegible] have all connections [illegible] posts made secure so as [illegible] extra unknown resistance [illegible] the shunt circuits. [illegible] be moved over the wire [illegible] pressure applied so that [illegible] be equally good at all [illegible] pressure should be [illegible] tend to reduce the [illegible] render the bridge [illegible]

[illegible] Testing Set is [illegible] instruments and is [illegible] obtained. Instead of [illegible] silver wire for re-

sistance, coils are encased in a mahogany box and arranged and connected about the same as those of the resistance box previously described. The resistance of each coil is determined very accurately and this marked upon the outside terminals of the coils. The galvanometer of this set is a very sensitive instrument and is also contained in the box. The source of the current is usually a set of chloride of silver cells, also placed at one end of the box. These are connected so that any number may be used at will, thus increasing or decreasing the E M F when necessary. The Galvanometer and

Fig 85—Portable Testing Set

battery key are also mounted in a convenient place upon the instrument. The unknown resistance to be measured is connected at the two binding posts shown.

The resistance coils are arranged so that a wide range of work may be included with these portable sets, the work ranging for accurate measurements from .001 to 400,000 ohms.

When using this set the same care and attention should be given as was explained with the resistance box. All plugs should be firmly placed and their contact surface kept as clean as possible. The complete set should be kept free from dirt and moisture.

We have already explained the most important instruments for measuring the voltage and amperage of the electric current. The electric power of the circuit may be found by multiplying the readings of the voltmeter and ammeter together. The result obtained will be the power in Watts.

The unit of electrical power or energy is called the Watt and may be found by multiplying the number of Amperes in the circuit by the voltage or E M F.

To determine the amount of electrical power used by the customer of an electric power plant for lighting or other purposes an instrument must be so constructed and operated as to include both the voltage and the strength of the current at the point where the measuring is done. The votlmeter and ammeter cannot be used as they do not determine the units for only a brief interval of time. and for recording work as would be necessary in this case they would be of no value.

However, an instrument by which this is accomplished was invented by Elihu Thomson, an eminent engineer of high standing. This instrument is called the Integrating Wattmeter and records the full amount of electrical energy of the current in Kilowatts Hours. If a current of one ampere flows through a circuit at a pressure of one volt for a period of one hour it is called a current of one Watt Hour. The unit Watt hour is, however, very small for commercial measuring, so, for commerce a much higher one was adopted, for the Board of Trade Unit, which is the Kilowatt hour. The Kilowatt hour is equal to 1000 Volt hours.

The Thomson recording meter con-

sists of a very small and delicate electric motor. The revolving part or armature is mounted upon a pivoted upright axle. The armature consists of many convolutions of fine wire, this being wound in very even layers on the armature which is not provided with an iron core. This armature with a resistance coil is connected in shunt or parallel to the main circuit, so that the strength of the current passing through the armature is determined by the difference of potential in the current which is being measured.

As we stated before it is necessary to make the reading from the effects of both the strength and the E M F of the current. So we connect the field coil of the motor, which is also without an iron core, in series with the main circuit so that the full current passes through them. The field in which the armature rotates is set up by this strong currrent of the main line passing through the field coils. Therefore, the current's strength that is passing through the armature combined with the pressure of the current in the fields causes the armature to rotate.

The upper end of the axle, which also rotates with the armature is connected to a clock work arrangement which records the energy in Watts and Kilowatts hours upon the face of the dial as shown.

It will be readily seen that unless a slight resistance was given to the axle of the motor, that upon connecting it in circuit it would at once attain a fast speed, and this would not be proportional in any way to the watts used which is necessary. To accomplish this, or to make the speed of the motor proportional to the watts used, a copper disk is placed at the lower end of the axle. This copper disk is allowed to rotate between the poles of the two powerful permanent magnets. The very powerful magnetic field that is set up between the poles of these magnets causes a slight resistance to the revolution of the disk. This drag, or retaining force, may be adjusted as necessary. If the meter runs too fast the poles of the magnet may be placed further away from the axle thus gaining more leverage upon the disk which causes the motor to run slower.

Fig. 31—Poliary Indicator.

There are many styles and sizes of recording meters now upon the market and all operate on about the same principle.

Fig. 32—Recording Wattmeter.

The Duncan Intergrating Wattmeters are perhaps as reliable and efficient as any now produced. Three views of the

meter are here shown. The design and operating features are strictly up to date and embody many valuable improvements which are not found in other instruments.

An entirely new means of compensating for friction and vibration on light loads is employed, consisting of a small multipoint switch in connection with the compensating coil and secured to the

Fig. 33—Wattmeter, side view

back of the meter between the series field coils and the magnets. By simply moving the switch arm over the contacts any desired degree of compensation can be secured in any instant. It is a very simple, quick and effective means and is absolutely permanent.

Another important feature of these instruments is the visible bearing which permits an inspection of the jewel and spindle point when the meter is in operation. When its collar is turned so as to expose the bearings, the detachable points of the spindle may be removed with a small pair of tweezers, either through the opening in the collar or through the jewel port hole in the base of the meter. Before removing the spindle port the jewel port should be taken out so as to give more room for operations.

Fig. 34—Wattmeter, front view

The detachable spindle point is not threaded but is held in the end of the spindle by magnetic attraction and is made from a special superior quality of steel wire made for this purpose. When handling the wire spring which holds the jewel port in place care should be taken not to pull it downwards but always to one side.

The connections and use of these meters in regard to house wiring will be taken up and discussed fully in later chapters.

(To be continued.)

DRAFTING DEPARTMENT.

Tricks of the Trade.

I. F. BOYNTON.

IN this day of "hurry-up" the constant cry of the employer is for more work in less time. To meet this cry many draftsmen see but one way—that of doing poorer work. The drawings are dirty, the lines are uneven, the parts are mixed up in an almost hopeless mess, and the whole presents an offensive effect upon the eye.

[illegible]

out the country as draftsmen are, the only way in which they can sort of visit together and swap these ideas is through the medium of some such magazine as this, and advantage should readily be taken of the opportunity thus afforded. It is hoped that the "tricks" contained in this article may prove of use to some, and further that they may call forth others, and that a chain may be thus formed which will soon be of great value to us all.

CLEAN INSTRUMENTS.

[illegible] good work, it is very necessary [illegible] clean the pens of all ink. [illegible] piece of chamois skin [illegible] eraser No. 112 made [illegible] has just enough [illegible] remove [illegible] metallic parts of in- [illegible] scratching, and will be [illegible] for this purpose.

[illegible]

[illegible] have trouble in keep- [illegible] It is necessary to [illegible] over the work. [illegible] the lines are blurred or [illegible] graphite from the pen- [illegible] and left upon the clean [illegible] This may be avoided [illegible] upon an ordinary [illegible] the drawing, especially [illegible] doing freehand let- [illegible] may seem cumbersome [illegible] short time, one will [illegible] that the hand will [illegible] unless resting upon a

[illegible]STRATION.

[illegible] draftsmen are bothered by an

bundant flow of perspiration (and especially is this so in warm weather), which, of course, rusts the instruments, and makes it generally disagreeable to work. To avoid this place at a convenient part of the board some talcum powder, and as often as necessary rub a pinch of it upon the hands. A few applications will fill up the pores so that very little moisture will come to the surface, and this may be readily absorbed by fresh powder.

BORDER LINES.

All drawings should be inclosed in a neat border, which may vary with the class of work, but the greater part in almost all cases is composed of one or more straight lines parallel to the edge of the paper. Suppose, for example, that the border is to be of single lines one-half an inch from the edges; then the ordinary method would be to scale off the one-half and draw the lines, first in pencil, and then in ink. However, if a number of sheets are to be made with similar borders, then much time may be saved by forming a small piece of card board into a right angle triangle with about three inch sides, and cutting out of this a smaller similar triangle whose sides are one-half an inch from the outer sides and parallel to them respectively. By placing the sides of the triangle to coincide with the edges of the plate, the corner of the border may be located, and by treating each corner successively, four points are determined by which the lines may be inked in at once as there is no doubt as to where they end.

INKING.

Before inking a drawing, it is well to remove with a soft eraser (Faber No. 112) most of the pencil mark, and especially if a soft lead has been used, or if the lines are very heavy. If this is not done, the ink can not adhere to the smooth, more or less oily, surface which the graphite forms, and will, therefore run off to the paper making a ragged line. On the other hand, if only enough of the pencil line is left to show faintly, then a fine groove made by the pencil will be filled with ink which will readily hold to the paper, and the result is a clean cut line.

RADIAL LINES.

Very often it is necessary to draw a number of lines radially from a common point—for instance in laying out an ordinary disk cam. A simple way of getting these lines even is to drive a fine needle into the board, and perpendicular to it through the center point, then by resting the straight edge against the needle and turning it about the latter as an axis, any number of lines may be drawn radiating from this common point. In inking such lines, if they are very close together, the pen should be drawn toward the center, because if the line is started near another, a blot is very apt to occur, and this will be drawn out with the pen getting worse and worse, while if the other method is used, the blot, if it occurs at all, will be reduced as the line is continued.

TO DIVIDE A SMALL CIRCLE INTO A LARGE NUMBER OF PARTS.

Not long ago, the writer in representing a disk of a dynamo armature had occasion to divide a circle 2 inches in diameter into 94 equal parts. After making several attempts to set the dividers to step off the spaces and failing every time by from 1-16 to 1-8 of an inch, he stopped to do a little figuring. Now suppose the dividers went around 94 times and 1/8 of an inch over; then in order to get 94 divisions the space between the points would have to be shortened by 1-94 of 1-8 of an inch, which is 1-752 or .0013 of an inch—a distance so sr

that it is practically impossible to lay it off on paper, and any attempt would doubtless result in getting something under 94 divisions. Assume a circle drawn concentric with the original and with a radius sufficient to make the dividers, without changing the setting, go around exactly 94 times. The circumference of this new circle will be about 1/8 of an inch longer than the original or 6.2832 + .125 or 6.4082 inches, and the diameter will be 2.04, and radius 1.02. The compass may now be set from 1 inch to 1.02 inches, the new circle drawn, and the dividers stepped around it 94 times, and then by the method for drawing radial lines, the circumference of the original circle may be divided into 94 equal parts.

System.

It is not the object of this short article to discuss machine shop systems, drafting room systems, etc., but to take up, in a very brief way, the systematic manner in which a draftsman may do work and thus save time and avoid complications. I thoroughly believe in systematic work. Plans carefully thought out in advance surely save time in the end and mean much more comfort for the workman.

Let us first consider the systematic manner in which a free-hand sketch of a machine may be made. If possible, the several parts of the machine should be laid out where a good view may be obtained of each one, and from that time on should be handled as little as possible. The best way is not to handle the model until it is time to take the dimensions. Taking the steps to be followed in free-hand sketching in their logical order, we would have the following:

1. Lay each piece in such a position that the views may be obtained without disturbing the model.

2. Study each piece carefully to determine the number of views necessary to fully illustrate the model. If a note will save the making of a view, do not hesitate to use it. For standard parts, such as set screws, nuts, etc., use simply notes.

3. Draw the views, using one sheet or series of sheets for castings and another for steel work.

4. Put on all dimension lines and arrow heads.

5. Look sketch over carefully, to see that it fully illustrates the model and that all dimension lines are in place.

6. After all sketches are complete, measure the objects carefully and put on the dimensions.

By reference to the above, it will be seen that it is not necessary to handle or touch the object from the time of placing the model for sketching to the taking of the dimensions, this means clean sketches and consequently clean drawings. It the draftsman sees that the parts are wiped off as they are taken from the machine and then refuses to touch them after placing them for sketching, he cannot help but have good, clean sketches. When taking dimensions, he needs to use usually only the left hand, using the right for handling the sketch and placing thereon the dimensions.

Some draftsmen prefer a sketchbook, others loose sketching paper. I think a good combination is a sketchbook of the loose-leaf variety which allows the workman to use or work on the sheets separately, at the same time giving a chance for filing as unit.

In detail work, drawings of castings should be made first, beginning with the largest and most complicated pieces. This allows the patternmaker to get the patterns ready by the time forging drawings are ready for the shop. This brings

drawings, forgings and castings into shop at about the same time; in fact, arer together than by any other ar- ngement.

When inking a mechanical drawing following will be found a convenient ler, which I will submit without com- nt.

ORDER TO BE FOLLOWED WHEN INKING.

Group 1.	Object lines. Black.	1. Arcs of circles, begin with the largest. 2. Irregular curves. 3. Horizontal lines, begin at the top. 4. Vertical lines, begin at the left. 5. Oblique lines.
Group 2.	Center, witness and dimension lines. Red.	Same order as Group 1.
Group 3.	Dimensions and Arrow Heads, Notes, Title. Black.	Ink in order given.
Group 4.	Section lines. Black.	
Group 5.	Margin lines. Black.	

The term "witness line" in the above y be new to some, and for that reason y require an explanation. The term fers to the line extending out from e object line and limiting the dimen- n line.

Should the system in your shop re- uire that the lines under group 2 be ade in black ink, it would still be neces- ary to ink them in a separate group s they would proably be made lighter han the object lines.

If shade lines are employed, the straight lines under group one should be subdivided, inking all the fine lines first and then all the shade lines. The same rder—horizontal, vertical and oblique— hould be maintained.

A Portable Drawing Table.

Amateur draftsmen, especially stu- dents, seldom have suitable tables upon which to work. The dining, library or mall bed room table cannot be made to answer for a regular drawing table with any degree of comfort, for the various positions of the board necessary for dif- ferent parts of the work can be secured only at great inconvenience. To tilt the board the left hand must hold it in the required position, and at the same time manipulate the T-square and triangles.

The accompanying drawing illustrates a method of turning an ordinary drawing board into a portable drawing table at a trifling cost. For this purpose three or four pair of hinge butts are purchased at the hardware store for a few cents a pair. The part of the hinge with the projecting tongue (a Fig. 1) called the "male" and the other part (b Fig. 2) the "female." Two females are screwed to the under side of the drawing board (b Fig. 2) flush with the edge as shown in the drawing, and one male is screwed in the center of the board, about five inches from the edge (c Fig. 2).

A piece of one inch thick board is now cut to fit the window, as shown. The board being narrow can be made to fit quite snugly into the groove in which the window sash slides by inserting it on an angle. Two male hinge parts are screwed to the upper edge of this board (a Fig. 1). The distance between these hinges should be the same as the dis-

tance between the hinges on the drawing board, so that the parts may be slid together, holding the board. The length and width of the window board will vary according to the width of the window, and the height of the sill from the floor. It should, however, be of such width as board, when the support is standing on end on the floor. To fasten the support in position it is only necessary to slide the two hinge parts together, and a substantial drawing table is formed. The drawing table thus constructed may be tilted to any angle by simply moving the

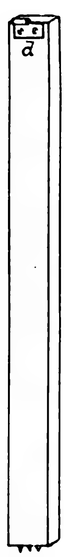


Fig. 3

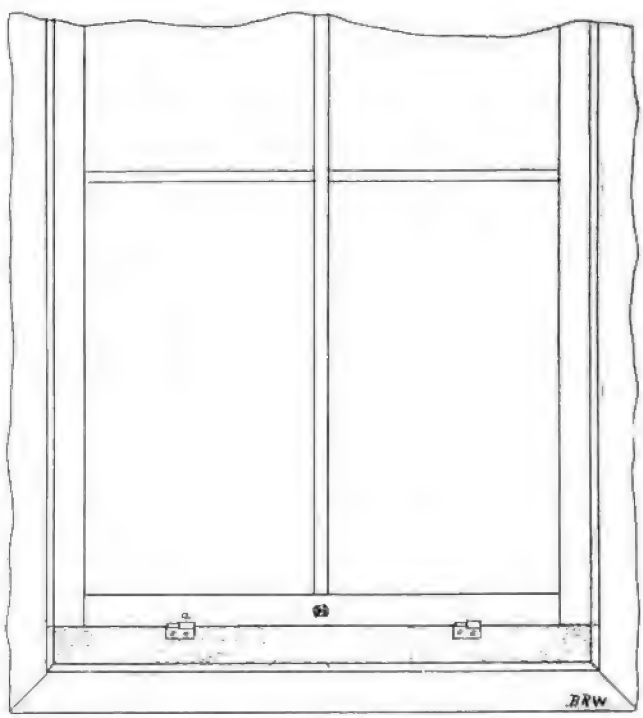


Fig. 1

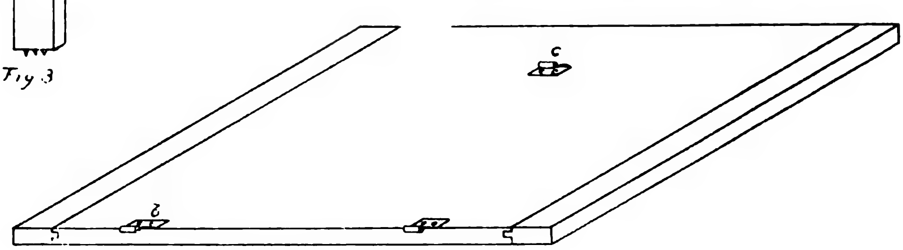


Fig. 2

to bring the top of the board about three feet from the floor.

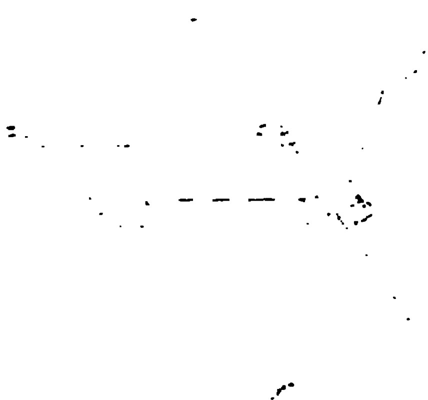
For a support for the lower edge of the board a stout piece of board is provided at one end with a female hinge part (d Fig. 3). The length of this support should be such that the hinge will be level with the hinges on the window lower end of the support in towards the wall. Three or four large brads driven in the bottom of the support and filed off to leave points projecting about one-fourth inch will give it a firm hold on the floor and prevent slipping. This drawing table may be tilted to any angle by simply moving the lower end of the

upport in towards the wall.

In putting on the hinges care should be taken to arrange them so that the board slides on to the right. If they are put on the other way, the pressure of the T-square head against the working end of the board would cause it to slide off.

In the summer time, when it is necessary to leave the window open, the window board can be made secure by driving in small wooden wedges at each end.

Having provided the drawing board with female hinges, male hinges may be placed in various places about the room, such as under the table top, window sill or on a board nailed to the wall. Thus



the student secures a serviceable portable drawing table that can be moved about at will and stored in an out-of-the-way place when not in use.

Figure 4 illustrates a neat drawing table that can be constructed by anyone with a hammer, saw and chisel.

The kind of wood to use depends entirely upon the maker's taste and the size of his pocket-book. Oak is the best, but pine will answer.

The stock of the frame is one and one-fourth by three inches. The top is one inch thick, twenty-seven inches wide and thirty-six inches long. The cleats on the end make it possible to use the top of the table for a drawing board.

The height of the table is thirty-five inches. The legs are twenty-nine and one-half inches apart, outside measurement. They are halved together but not flush, and held in place by keyed mortised-and-tenon joints on the cross pieces. The spread of the legs at the bottom is twenty-three inches, outside measurement.

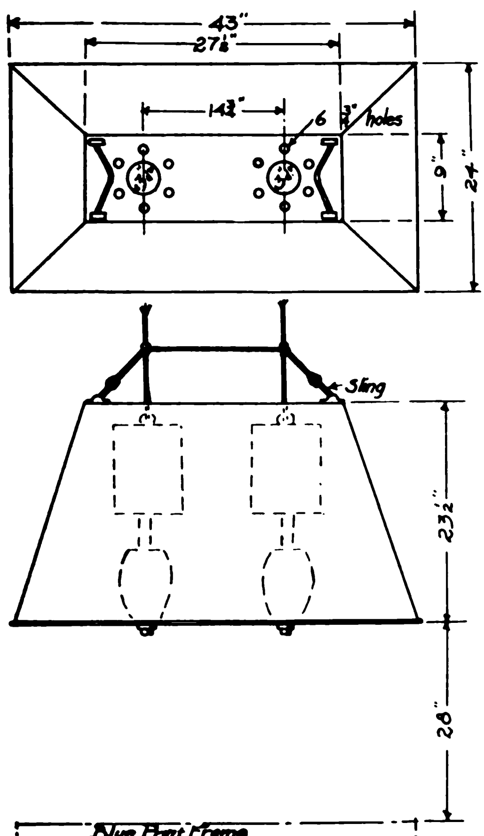
The table may be painted or finished in any way that suits the builder's fancy, but probably the most satisfactory way would be to stain it in imitation of the popular Mission Furniture. The stain may be purchased mixed and ready for use, requiring no skill whatever to apply.

An Electrical Blue Printer.

The following account of an electric blue printer as made by a small company may prove interesting.

It was found that there were so many prints to be made, and so many cloudy days to prevent rapid printing that prints that should be in the shop were being delayed. Prices for several electric blue-printers were received; but they all seemed a little high. Then one of the electrical men proposed that the company make one for themselves. The suggestion was adopted, and the sketch, which I am sending under another cover, shows the apparatus as designed by Mr. E. R. Bryant. It is made of tin and was built by a local tinsmith. It was made of the same dimensions at the bottom as the blueprint frame as it was intended to lower the reflector to within one or two inches of the frame when in use. Upon experimenting with it it was found that with the reflector down close to the frame the print would be burnt in the middle, while barely printed at the edges. At a distance of about 28 inches from the frame, and 3½ minutes time the best print was taken.

The lamps used are two Adams Bagnall Enclosed Arcs, direct current, and they are suspended directly upon cords running up over pulleys down to cleats by which the position of the reflector may be regulated. The manner by which



the reflector is slung to these cords is clearly shown in the sketch. The resistance for each lamp is suspended from hanger board on ceiling so that their weight does not have to be handled in raising and lowering the reflector.

L. E. Vator.

Question Box.

Q.—Please give me a rule for figuring the contents of a tapering tank 10 ft. in diameter at the bottom and 9 ft. in diameter at the top and 8 ft. 7 in. high. What would be the weight if filled with water?

A.—To solve this, we would have to find the contents of a solid similar to a frustrum of a cone. Add together the area of the bottom and the top in square feet, and divided by two. This would give us the average area. Multiply this average by the height, which will give the solid contents in cubic feet. Allowing 7.5 as the number of gallons to the cubic foot, which would show the number of gallons in the tank. Multiply the number of cubic fet by 62.5, which will give us the weight of water in the tank. Adding to the weight of water in the tank and getting the total support it will have to carry.

Falling Bodies.

"John, what distance will a body fall in three seconds? Of course the theoretical distance is meant of a body falling in a vacuum."

"Oh! that's dead easy," said John. "Why, there is a formula in my handbook, and I don't know but what there is a table, that will tell the distance at a glance. I'll let you know in half a minute.'

"No, John," said his chum, "let us suppose you are passing some examination; you would not then be allowed to have resource to that *vade-mecum.*"

John's eyes twinkled a little, for he had luckily been reading on this very subject the previous evening, but he did not think it necessary to enlighten his friend on this point.

"Oh! well, said John, "I remember that a body falls 16.08 ft. in the first second, and that the acceleratrix is 32.16 ft., or just twice as much, or, in other words, that at the end of each second the body acquires a velocity of 32.16 ft.: hence at the end of two

will have acquired an additional velocity of 32.16 ft., making the velocity at that moment 64.32 ft.

"Since the body started from a point of rest and acquired a velocity at the end of one second of 32.16 ft., its average velocity was 16.08 ft; therefore that is the distance it fell in one second; and in the same manner the average descent in the next second would be

$$\frac{64.32 + 32.16}{2} = 48.24 \text{ ft.},$$

and this added to the distance fallen in the first second equals 64.32 ft.

"At this moment we find the velocity and the total descent are represented by the same figures.

"The velocity at the end of three seconds would be $64.32+32.16=96.48$ ft., and the average distance fallen in the third second would be

$$\frac{64.32 + 96.48}{2} = 80.4 \text{ ft}$$

and if we add to this 64.32 ft. it gives 144.72 ft. as the total descent in three seconds."

"Your answer is correct, John, and some of the formulas ought not to be hard to see into from your reasoning. I am going to note down your explanation and also some of the formulas."

m = mass.

g = 32.16 ft. per second.

W = weight of a body at the surface of the earth.

w = weight of a body at a given distance above or below the surface.

D = distance between the center of the earth and center of the body.

R = earth's radius = 4000 miles.

T = time in seconds the body falls.

V = velocity in feet at the end of the time T.

H = distance in feet that a body falls during the time T.

mV = momentum.

$$M = \frac{W}{g} \qquad WR = DW \qquad WD^2 = WR^2$$

$$V = gT \qquad V = \sqrt{2gH} \qquad V = \frac{2H}{T}$$

$$T = \frac{V}{g} \qquad T = \sqrt{\frac{2H}{g}} \qquad H = \frac{V^2}{2g}$$

$$H = \frac{gT^2}{2} \qquad mV = \frac{WV}{g}$$

"John, did you ever try dropping at the same time objects as dissimilar as a cork and a bullet for a distance of several feet?" "No," said John, "I don't think I ever did." "Well, I have tried it," said his friend, "and both objects will reach the ground in the same time, but if they are dropped a greater distance, say from the second story of a building, the bullet will reach the ground first.

"Again, talking about weights, puts me in mind that the term mass represented by m may be taken as signifying the mechanical effect of a weight falling during a second of time or through 32.16 feet."

"Yes," said John, "that seems like a good explanation, but I shall have to go now, as it is getting late." *Charles A. Calvert.*

From a Reader.

Mr. Editor:

I am very much pleased to see another Constitution and Laws of a newly organized society of Hampden County Draftsmen. This is another evidence of the necessity of a national society of draftsmen.

I like to read a good, sound article, full of earnest and logic, such as expressed by Mr. Maxim O. Freuier, on organization.

Come, brothers, be up and doing; get enthused; have something to say; let there appear several articles on organization in the next issue.

"A PENCIL PUSHER."

CURRENT TOPICS.

Back copies of THE DRAFTSMAN can be secured at any time. Bound volumes are on sale, see advertising pages.

Send in for our special offers as premiums for new subscribers. Many good things offered and each should take advantage of them.

Is this convention year for draftsmen? How many can join together and send a delegate to Cleveland in June or July? Let us hear from you on this subject.

The January issue has been exhausted but perhaps all orders can be filled before long.

A large number of each issue is placed with the newstands for sale but some are returned. When the returns come in, the standing orders can be filled.

As much as possible, it is intended to make this magazine a "data bringer" to the reader.

Such matter that is reprinted will give useful information to our readers.

There is no doubt that subscribers of technical magazines are looking for concise information, such as will help them in their work, if not at this time, perhaps in the near future, so put it away where you can lay your hands on it when you want it.

Standard Size Cards.

Mr. W. Osborne, in the American Machinist, says: "As many things can be just as well done any one of the several ways, and as some of these ways may give trouble, we try to have standards adopted.

"Standards are simply labor-saving devices. At first it is only the very great and important thing that is standardized, and this because the necessity for it is very plain and the saving very great, or it may be the trouble caused by the lack of standard is so universal that many people are ready for anything that saves them annoyance.

"I would like to see a standard card adopted by traveling salesmen."

The writer further remarks the inconsistency of the practice of having so many sized cards.

What should be done is to have a small card with the name of the firm and salesman for announcement, and to have a 3 x 5 card with information of suitable character.

These cards would fit into the ordinary desk drawer tray and could be readily handled and thus kept for future use.

If the user calls for a standard size and the maker advises it in cases where his opinion is asked, we will have it and it will be better than the dozens of sizes now in use.

If they were all made of the most inconvenient size in the lot, it would be better than the present state of the art.

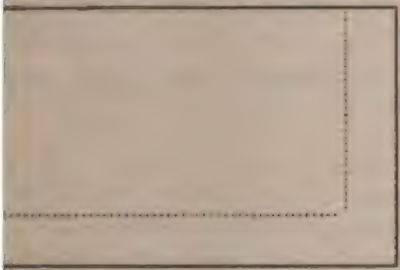
As the Irishman said when he was fighting the mosquito, "'Tis not the size or the danger of the thing that I object to, but the waste of time and the distraction that it produces."

Cards could be used to send to prospective buyers any informa- [illegible] the

cturer wishes to give out, but they be 3x5, 4x6 or 5x8.

E. J. Lees, Cleveland, Ohio, has d a means of adapting a card to e of several sizes of trays, es- the 3x5 and 4x6, which are by most common.

eferring to the illustration, it will that perforations are made so uld any one receiving a 4x6 card ing a 3x5 tray, he can easily de- e size to suit his requirements.



ations, descriptions of new ma- etc., may thus be presented to the n acceptable form.

ngements can be made with Mr. r the use of this card.

Personals.

C. C. Maison, formerly instructor ting and design at Central Insti- leveland, and who wrote many

for this magazine, is now con- engineer for the Antilles Metalic g Co. Mr. Maison is the patentee of several electrical and steam devices which are to be manufactured by the above company.

The illustration shows the packing to be made by this company and has proven the best packing device on the market.

It is being used by the Erie R. R. and Lake Shore R. R. and the White Automobile Co.

It is the only packing device that compensates for friction, lubrication and is self adjusting.

American Technical School.

As mentioned in previous issues of this magazine, a course in Concrete Steel Construction was under way and the prospectus is now ready.

The American Technical School of Cleveland has been organized to give instruction in this class of work.

Their aim is to teach principles and not to furnish the students with a lot of undigested information, nor to work off on them a number of high priced publications.

There are twenty-five lessons in the course which is arranged mainly for engineers, contractors, draftsmen and architects of the younger generation.

Those who are not familiar with the principles of mechanics are advised to take twelve lessons arranged to supple-

ment the course in Re-enforced Concrete.

No branch of the engineering profession is in greater demand today than that connected with re-enforced concrete.

It is one of the future means of construction and no young man in engineering work should pass this opportunity to prepare himself. Address Lock Drawer O.

Book Reviews.

The Train Despatcher's Bulletin, published in Toledo, Ohio, is devoted to the interests of men in this profession.

"House Hints" for those who build, buy, improve or rent, by C. E. Schermerhorn, is a practical treatise describing every essential detail pertaining to site, location, arrangement, construction, plastering, heating, plumbing, lighting, decorating and furnishing of the house. The book opens with the "index" arranged so that any one of the 150 or more headings can be easily located.

Many valuable suggestions are made on the 55 pages for the benefit of the amateur builder. Pages 6 x 9, paper bound, price 50 cents. Address House Hints Publishing Co., Philadelphia, Pa.

After twenty years experience as a mason, Mr. W. H. Baker has written "The Cement Worker's Hand Book," a neat cloth bound book of 86 pages, covering more than fifty most important subjects on cement and its uses in construction.

The work is divided into five parts: Properties, Mortars, Concretes, Cast Masonry and Practical Notes, each compiled to meet the requirements of the common workman.

The latter division covers many interesting and useful notes on hair cracks, freezing, moulds, measurements, seasoning, coloring, testing and cost of cement work. The price of the book is 50 cents from Mr. W. H. Baker, Wadsworth, O.

New Catalogues.

Circulars and diagrams of marine gasoline engines have been received from Gray & Prior Machine Co., Hartford, Conn.

Yale & Towne Mfg. Co., are noted for chain blocks of every kind. Their general catalog describes three kinds and fifteen sizes, for every hoisting need. The Company has offices No. 9 Murray St., New York.

Roller bearings are of such common use that they need no introduction. The Standare Roller Bearing Co., Philadelphia, Pa., need none either. Their Catalogues No. 12 and 16 describe every possible use for such an article.

"The Uses of Locomotive Cranes" is the title of Bulletin No. 23 issued by The Browning Engineering Co., Cleveland, O. Illustrations show cranes in a great variety of work demonstrating their adaptability to the handling of material economically.

Bulletin 56 of the General Pneumatic Tool Co., Montom Falls, N. Y. illustrates electric hoists. Diagrams and tables are quite complete, more so than usually given in advertising literature.

The Brunswick Refrigerator Co., New Brunswick, N. J. have issued a general catalog on refrigerating and ice making machinery.

The Antilles Metalic Packing Co., 191 Bank St., Cleveland, O., announce circulars on frictios and lubrication in stuffing boxes. They are manufacturers of packing for engines, pumps, compressors, locomotives, etc.

VOL. V MAY, 1906 NO. 5

BROWNING'S INDUSTRIAL MAGAZINE.

THE CHICAGO SUBWAY TRANSPORTATION SYSTEM.

A City Freight Railway Operated Underground by Electric Power.

By FRANK C. PERKINS.

THE details of track and trolley construction in the subway of the Chicago Underground Electric Freight Railway System, as operated by the Illinois Tunnel Co. is shown in the accompanying illustrations, as well as the electric locomotives and trucks, showing trains of freight cars at the intersection of various

streets and the method of operation. There are 33 miles of tunnels of a section 6 ft. x 7 ft. 6 in. each constructed under the centers of the streets of the city of Chicago. This underground freight railway system has been in operation for several years, the subways being extended each year until the problem of relieving the congested area of this large city is being rapidly solved by doing away largely with the operation of heavy loaded trucks upon the streets. In the same manner as the building of subways and underground railway tubes for passenger traffic below the surface is intended to relieve the congested area of such large cities as London, Berlin, Paris and New York, so the building of this subway or tunnel system for the transportation of merchandise, coal, newspapers and mail matter, is intended to aid in the solution of this problem.

This tunnel system was commenced several years ago by the Illinois Telephone Construction Co. under the direction of George W. Jackson as general manager and chief engineer; the subways are being built under an ordinance granted to the Illinois Telephone and Telegraph Co.

The business district of Chicago comprises about one and one-half square miles of territory and is completely surrounded by the passenger stations and freight depots of the 25 trunk lines, which make Chicago the greatest railroad center in the world. It is estimated that the freight handled daily at the freight depots in Chicago amounts to more than 112,000 tons, and with the present facilities afforded by the tunnel, will relieve the congestion and facilitate the transaction of business in the business section, removing about 80 per cent of the heavy teaming from off the streets.

The tunnel as built is egg-shaped, with walls of concrete, the walls being 10 inches thick with a 14-inch bottom. They are 6 feet wide and 7 feet 6 inches high, inside measurement, and are at an average depth of 40 feet below grade.

The pneumatic system of constructing subways was used, although a number of thousand feet were constructed without the use of air. The work is pushed day and night, and the 24 hours are divided into three eight-hour shifts. The shift which goes to work at 4 p. m. being known as the driving shift; this shift is relieved at midnight by another shift that finishes the drive, taking out the bottom and does the trimming. The day shift does the concreting. Special precaution is observed at every stage of the work. Half-hourly reports of the progress of the work are forwarded to the chief engineer's office, and by fluctuation of the air pressure, or any change in the nature of the soil is immediately reported to the chief engineer in person, who remains in touch with the work constantly.

A great advantage is claimed for the concrete tunnel over a brick one, as there is no chance for a settling of the streets. In using brick it is impossible to dig a tunnel so true that the brick will fit snug, consequently they are obliged to back fill with clay, slabs, or other material that is handy; this leaves voids which are bound to cause settlement. In the use of concrete it is necessary to tamp the concrete tight to get a perfect bond, and in so doing it fills up every void no matter how uneven, making it an impossibility for any chance of a settlement. It is with just pride that the management can say that from the time the work was started, up to the present date, the company has not received one complaint of any damage having been done to the streets of Chicago or adjoining property.

It is stated that more than 175,000 lineal feet of tunnel has been constructed up to th The

system now reaches every passenger depot and freight house, and connections are being made with these as well as the warehouses, wholesale houses, retail houses, manufacturers, etc., as fast as the alterations necessary in the building can be made. The first railroad to make provisions to use the subway was the Lake Shore & Michigan Southern, in their new freight house at Clark and Taylor streets.

During the months of April and May there were five miles of tunnel constructed under the streets of Chicago. During the month of April there were constructed 11,105 lineal feet, and during the month of May there were constructed 12,619 lineal feet of tunnel, with the necessary appurtenances to make it practical to operate electrically propelled trains; such as rails, trolley system, permanent lighting, drainage system, etc.

The construction of this number of feet, with the necessary intersections, by-passes, etc., in the time mentioned above, is something entirely out of the ordinary. When it is taken into consideration that the general average in tunnel construction up to the present time has been at the rate of two miles per year, even under the best conditions and where the soil has been uniform. In carrying out the work it has been necessary during the past two months to excavate about 60,000 cubic

yards of material, and manufacture and place into position about 35,000 cubic yards of concrete. All the excavated material was transported through the completed tunnel system and deposited at Grant Park, at which point it is being used for filling for the improvement of the park. In connection with the same, there was transported through the tunnel about 1500 cubic yards of excavated material daily from the following buildings:

Heyworth Building, Majestic Building, Mandel Brothers, Marshall Field and New Edison Building and, in fact, all the new buildings being erected in the down-town district are having their excavated material hauled by the tunnel company. The benefits to the people and the users of the streets of Chicago has been very great of late, due to the transporting of excavated material and wreckage through the tunnel system. It has been the means of keeping a large number of teams off the streets, which have previously been engaged in hauling refuse and excavatings from the new buildings. The benefits to the community are many, as it has already been the means of removing a part of the congestion, as well as keeping the streets free from dirt and refuse, which has always fallen off the wagons engaged in this class of teaming.

Many structures have been built in New York, Boston and Philadelphia, which extend 30, 40 or 50 feet below the street surface, and such basements are now being built in Chicago, and will be available in a way more advantageous than in the above named cities, since the floor of the sub basements will be carried to the level of the subway.

On account of the many styles of buildings which are to be tapped, and the many purposes for which the tunnel is designed, there has been a severe tax on the engineers' ingenuity, as no two buildings are alike, and each requires its own treatment. Where the tunnel connects with a building whose basement extends but one story below the street grade, a turnout or by-pass is constructed leading from the main tunnel to the inside of the curb line where it connects with a shaft leading to the basement under the sidewalk. Specially designed elevators lift the cars to the basement floor, where, with the use of a turntable they can be moved wherever they are desired. The elevators so far in use are tested to carry 30,000 pounds.

The permanent track has a gauge of 2 feet, and the Illinois Steel Company 4¼ inch 56 pound rail was adopted as the standard rail. The rail is fastened by U bolts to a specially designed cast iron chair embedded in the concrete floor of the tunnel. The great number of crossings and switches in use necessitated by all the intersections, turnouts, or by-passes, leading to the different buildings, made it imperative that this part of the track system be as near perfect as could be made. The crossings in use are all bolted to steel plates that extend over the entire crossing, and this embedded in the concrete floor. The switches are those known as the split switches, and the frogs are constructed the same as the right angle crossings.

Except at the incline at the lake front, where the Morgan third rail system is used, the overhead trolley is utilized throughout. The third rail consists of a steel strip about one-half inch in thickness by four inches wide, clamped between insulated wood stringers laid lengthwise in the center of the track. The rail furnishes not only the current for the locomotives, but the means of moving the locomotive as well, for it is provided with an opening for cog wheels, which are pressed onto the axles. A 0000 figure 8 trolley wire is adopted as the standard, held in place by Porter & Berg's standard barn trolley hangers placed 15 feet on center.

It is intended that automatic section insulators and throw will be in use at all street intersections. This arrangement enables the current to be cut out in any block during temporary repairs, without shutting off the current from any other part of the system.

The style of cars and electric loco-

motives used for this work are varied and interesting. On the incline at the Lake front it was found advisable to use the Morgan B type of locomotive; while in the tunnel proper there are two types in use, viz: The Jeffrey's Standard M. H. locomotive, and the General Electric Standard L. M. locomotive. The weight of the Jeffrey locomotive is six tons and is equipped with two 18 horsepower motors. While the weight of the General Electric locomotive is five tons, and it is equipped with two 20 horsepower motors. The locomtives are of a low and compact construction.

The cars which are employed in the Underground Railway Freight service are the Kilbourne & Jacobs, and the Bettendorf double truck type. The cars are 12 feet 6 inches in length over all, and 47 inches in width. They are of steel and iron construction throughout and can be used either as a gondola or a flat car, and every car is equipped with the M. C. B. coupler. The weight capacity of the car is 30,000 lbs. The double trucks are so built that the cars readily operate upon a curve of 15 foot radius. At the present time the box cars are equipped with the Newman patent dump box, which has a capacity of three and one-half yards. The number of locomotives and cars now in use is large, and is rapidly being increased.

The tunnel is well lighted throughout by electricity. The current for light and power is supplied at present by the Chicago Edison Company. Power for the trains is furnished by a 5,000 horsepower generating plant. Direct current at 250 volts, the rails furnishing the return, is the system in use.

The Northwestern University has deeded a tract of land on the Chicago

River, at 24th, to the Tunnel Company, where it erects its own power house. The company also erects large warehouses where it will be possible for merchants who have only limited amount of space to store a large supply of goods, drawing upon the same as needed. These warehouses the Company erects on its own property on the west bank of the river at Taylor street.

At each intersection of the tunnel there is an automatic telephone, and all trains are operated by this system. The cables for the telephone system are hung from the roof of the tunnel with a specially designed adjustable strap. Guards are stationed at street intersections and every precaution is taken to avoid accidents. The many connections already made with the tunnel insured thorough ventilation. The floor of the tunnel is dry and smooth as the average cement pavement. The subway freight lines now extend from Indiana Ave. on the north to 15th street on the south, and west as far as Halsted street, and are rapidly being extended beyond these limits. This system of underground freight transportation will undoubtedly be utilized in other large cities in the near future, both at home and abroad.

ELECTRIC HOISTING PLANT FOR EMPTYING VESSELS.

Erected by the C. W. Hunt Co., N. Y.

The plant illustrated herein handles 25,000 tons of coal yearly, is situated in New York Harbor, and is equipped with "Hunt" electric hoist and automatic railway. The coal is hoisted by means of the electric hoist, from the canal boats in 1-3 ton tubs, on a mast and gaff, to the automatic railway car, by which it is distributed in the yard. The car runs on an elevated self-acting railway and requires no steam, horse, or manual power for its operation.

General View of Plant for Emptying Vessels.

With the previous equipment the coal was hoisted by horse power and trimmed into the stock pile. The old equipment cost $1,750, the new one $2,800. The cost of handling to the stock pile, interest and depreciation included, was, with the old plant, 17¾ cents per ton; with the new plant the cost is 7¼ cents. This difference of 10½ cents per ton on 25,000 tons per year makes an actual saving of $2,625. Thus every 13 months the whole cost of the plant is saved in the reduction of the pay roll.

The unloading capacity with the old plant was 120 tons per day; with the new machinery the capacity is 200 tons per day, an increase of 80 tons.

The power is purchased by meter at 5 cents per horsepower hour, and costs less than 7 mills for each ton of coal hoisted and delivered to the car.

The labor required to operate the new plant, in taking the coal from the vessel to the stock pile, is as follows: Three shovelers are employed in the hold of the vessel, one man operates the electric hoist, another man dumps the coal into the car, weighs it, and attends to the automatic railway.

It has been found that the convenience of the new plant is another important element in its favor. It is always ready for service by switching on the electric current for driving the hoist. When the

unloading of a boat has been completed, the switch is opened and the attendants can leave the machinery at once. Another important factor is the facility for weighing the coal. The automatic car stands on the scale platform while being filled, and the exact weight of each load can be noted before the car starts on its trip.

COMPARISON OF ACTUAL COSTS OF THE NEW AND OLD PLANTS.

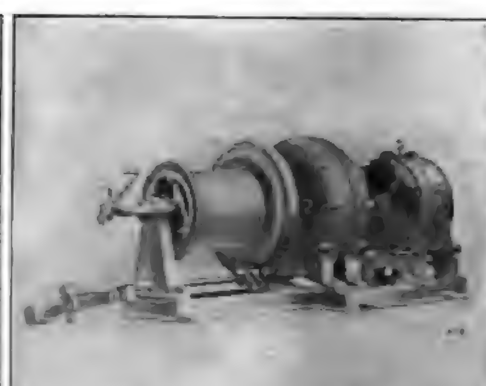
NEW PLANT.		OLD PLANT.	
The timber work, fencing, automatic railway car, tubs, scales, pocket values, electric engine, blocks, fall, mast and gaff, for the new plant cost	$2,800	The horses and carts, blocks, fall fittings, tubs, mast and gaff, for the old plant cost	$1,750

COMPARISON OF COST OF OPERATION.

NEW PLANT. Capacity 200 tons.		Per Day.	OLD PLANT. Capacity 120 tons.		Per Day.
3 shovelers, at.........	$1.50	$4.50	2 shovelers, at..................	$1.50	$3.00
1 hoister, at.....................	2.00	2.00	3 carts, horses and driver at................................	3.00	9.00
1 man to dump, weigh and tend automatic car, at...	1.50	1.50	1 hoisting horse and driver at................................	3.00	3.00
Electric power, oil, waste, etc................................	......	2.00	2 trimmers, at..................	1.75	3.50
Interest and taxes, yearly..	10%	2.24	Interest and taxes, yearly..	10%	1.40
Depreciation, yearly.........	10%	2.24	Depreciation, yearly.........	10%	1.40
(Two last items based on a year of 125 days' work.)		$14.48	(Two last items based on a year of 125 days' work.)		$21.30
Daily cost per ton in stock pile	7¼c.		Daily cost per ton in stock pile	17¾c.	

Thus saving 10½ cents per ton on 25,000 tons, or $2,625 each year. Every 13 months the cost of the plant is saved by the reduction of the pay roll.

Automatic Railway Car, with Truck, Dumping Block and Cross-Bar.



The Electric Hoist Installed. Gears are completely enclosed and run in a bath of oil.

MATERIAL HANDLING BUCKETS.

BUCKETS for handling materials of all kinds may be divided into two classes: the ordinary round or square bucket, either stationary with bottom dump or the turn-over, and those that dig or are self-filling.

There are many styles and sizes of the first class, the more common being the turn-over kind, and in late years the design has become so that they are made self-dumping, self-righting and self-locking.

The bottom dump is seen in sewer digging and the placing of concrete where the load is required to be deposited in a mass.

All buckets must necessarily be carried by some means or other, the more common being the overhead wire rope system, but there are a great many used on a single rail tramway controlled by hoisting and haulage ropes.

Fig. 1—Square Turnover Bucket, made by The Atlas Car & Mfg. Co.

In sewer work the buckets are raised and lowered by a cable having a hook on one end, allowing them to be detached and filled as fast as possible while the rope was being used for other purposes.

The square turn-over buckets or "tubs" are built by a number of concerns in sizes cubic feet capacity, and depend on the latch on each side to support them in the loaded position.

The illustration on our cover shows the use of the round bottom dump bucket handling coal.

As seen, the cars of coal are run up an incline high enough to dump the coal in chutes, which in turn deposit it in the buckets along the track of the crane, which is self-propelling.

Fig. 2—The "Scoop" Turnover Bucket made by C. W. Hunt & Co.

The buckets hold nearly a ton, and a careful operator can handle an immense amount of coal in a short time.

The round buckets are made in capacities of $\frac{1}{2}$ to 1 cubic yard, and the bail set a little below the center if to turn over, or placed up near the top if for a bottom dump.

In systems installed by the Broderick & Bascom Rope Co., St. Louis, Mo., the buckets or carriers are attached to the traction cable by means of a clip which swivels in the center clip frame between two dogs, thus allowing the carrier to hang perfectly perpendicular regardless

of the ascending or descending angle. As a carrier arrives at the loading terminal it is detached automatically from the clip on the traction rope. The clip passing on engages a loaded carrier and propels it to the discharging terminal, where the handle strikes a tripping device and allows the bucket to discharge its contents while in motion. This bucket then rights itself automatically, locks and travels to the loading terminal, at which point the operation is again repeated. In other systems the buckets must be detached at the discharging terminal as well as at the loading terminal.

They are manufacturers of the G. & S. patent self-dumping, self-righting and self-locking buckets, arranged to be tripped by a trigger on the wood work of the supporting system. Thus these buckets pass through all the above operations without the assistance of any attendant. These buckets are made in sizes varying from $2\frac{1}{2}$ to 57 cubic feet.

Sizes of round and scoop turn-over buckets are given on the data sheets in the supplement of this issue.

The bottom dump buckets being made by the Cyclopean Iron Works Co., Jersey City, consist of square sides with a hinged bottom. The locking device is adapted to open the bottom at the appointed time by means of a rope when used under water.

Fig 3—Showing Use of Square Bottom Dump Buckets.

These buckets are designed with a view of handling concrete and excavations, and arranged so as to deposit the load in a concentrated mass, without shock or injury to the forms or bracings in the case of work under water.

It is claimed that with the turn-over style provided with a hinged lid, concrete or other material may be deposited in about the proper consistency withou

less or aid from divers. They are in this way valuable to contractors engaged in sub-aqua work.

Similar to a bucket is the scale box made by the above firm, which is equipped with a door that opens automatically. As soon as the box is lowered sufficiently to permit door chain to become slack, door unhooks, and when again hoisted the contents slide out easily.

Fig. 6—Scale Box made by Cyclopean Iron Works Co.

In the June issue the subject will be continued by taking up the self-filling type of bucket, commonly known as grab buckets. This division of the subject will be very much more extended, as it will deal with the different makes after describing the principle on which this class of bucket operates.

Curing Stone With Steam.

Many have recently begun curing (hardening) stone with steam, and being always ready to learn any improvement that may arise, I have the past few months made several tests, none of which were, in my opinion, satisfactory.

Hollow blocks taken from the molding machine and placed in a chamber and subjected to 80 pounds steam pressure for two, four, six, eight and ten hours, were all hardened according to the time, viz.: the ten-hour block being the soundest. But I found that it was the easiest injured by acids and that the lime in the cement had drawn towards the surface, which will cause disintegration in a few years just the same as blocks made in the ordinary way with cement containing an excess of lime, only that in the steam-cured blocks its interior would remain sound.

As the steam-curing acts in the nature of baking the cement I find that such blocks are lacking in fireproof qualities, viz.: blocks made with cement 1,200 degrees fireproof when steam-cured, discolor at 450 degrees and crumble at 700 degrees, which is certainly a great reduction, and does not look well for the sand lime brick industry, but I have not had the time to make tests of the latter.

Blocks made of crushed furnace slag and cement can be more successfully cured by steam, as these did not show the least injury by heat and were unaffected by acid, but why, is the question I hope someone better versed in chemistry than I will answer.

The recent heavy advance in the price of Portland cement has done much to introduce cement made of furnace slag, sometimes known as Puzzalon cement. Heretofore I have condemned all slag cement for exposed work, but I have always known that a very great difference exists in this cement, hence I have given it much attention of late with very severe tests, and find that any cement containing much magnesia cannot be used in block work, but that cement made from slag that has a small per cent of magnesia is better than some Portland cement, as it is much stronger, but does not endure exposure.—*American Carpenter and Builder.*

THE PULSOMETER FOR CONTRACTORS' USE.

LIKE all inventions which have inaugurated a new departure in applied science, the Pulsometer has been much imitated, and since its first public exhibition in 1870, pumps have periodically appeared which, while professedly embodying the principles then disclosed, have, without exception, failed to secure that degree of efficiency and general adaptability to all kinds of uses for which the genuine Pulsometer has become so justly famed.

Years of practical work with the Pulsometer, under widely different conditions, have demonstrated the merits claimed for it in the most striking manner, and carefully conducted expert tests, made at Stevens Institute of Technology, one of the foremost engineering schools, have given figures for economy of performance which firmly establish it in its high rank of excellence among that class of water raising machinery with which it was designed to compete. They have entirely eradicated the erroneous impression held by some that it is an uneconomical machine in point of steam consumption.

The Pulsometer is a low-service pump, and is not recommended for duties exceeding about eighty feet total vertical service, although there are many erected under most favorable conditions, operating successfully on higher lifts; but the above figures may be safely taken as a guide for all practical purposes.

The main body of the Pulsometer, as shown in the perspective cut, Fig. 1, and the sectional cut, Fig. 2, is a casting, made in one piece and consisting of two bottle-shaped chambers, A, A, pla side by side. These are called work chambers. They taper towards e other at their upper halves and mee their upper ends at a point at whicl situated the steam valve-ball C. T

Fig. 1.

oscillates with a slight rolling motion tween seats (with which it makes a ste tight joint) formed at the upper trance to each of the already mentio working chambers, A, A.

The portion B, of the pump, containing the steam valve-ball C, is called the neck-piece, and is a separate casting bolted to the main body of the pump, so that it can be readily removed for renewal when necessary. To the upper part of this neck-piece, B, is bolted the neck-cap, into which the steam supply pipe is screwed.

The openings communicating between the chambers A, A, and the induction or foot-valve, chamber D are covered by suitable valves E, E, called suction valves, their valve seats F, F, and valve guards I, I, which latter prevent the valves from opening too far.

Fig. 2.

A third chamber, J, called the vacuum chamber, situated behind the chambers A, A, at their lower halves and between their upper, or tapering halves, ... with them through the round opening in the induction or foot-valve chamber D.

A fourth chamber called the discharge chamber, situated on the lower side of the working chambers A, A, opposite the vacuum chamber, J, and represented by the dotted lines in the sectional view in Fig. 2, communicates with each of the working chambers A, A, by passages at the lower half of its intersection with these chambers. This discharge chamber contains the discharge valves E, E, their valve seat G, G, and the valve guards I, I, which cover the passages leading from the chambers A, A.

The delivery pipe, H, connects with the discharge opening in the top of the discharge chamber by means of a flanged joint.

The induction, or foot-valve chamber D, contains the valve E, its valve seat F, and the guard I, which serve the purpose of holding the charge of water in the pump. The lower end of this chamber is connected to the suction pipe by a flanged joint.

K, K are oval plates covering the openings through which the seat, valve and guard are inserted to the respective chambers, and are fastened in position by means of strong clamps and bolts N, N. The ends of these clamps fit loosely into suitable recesses and are thus held in position while the cover plates are being applied. Another set of similar clamps and bolts serve, in a like manner, to fasten the seats, valves and guards in place.

The object in employing four openings to the pump instead of two, is to make it possible and convenient to get at every square inch of the interior for thorough examination, chipping and cleaning of the new casting, and ease of removing any deposit that certain classes of work might help to form on the walls of the chambers, and which could not be reached otherwise.

Vent plugs are inserted in the cover plates for the purpose of draining off the water in the pump to prevent its freezing.

Near the top of each of the working chambers A, A, and of the vacuum chamber J, is a small tapped hole, into which is screwed a brass air check-valve so that its check hangs downward.

The air check valves in the chambers A, A, allow a small quantity of air to be automatically admitted above the water, and ahead of the steam, separating the steam and the water upon their first entrance, thus preventing condensation, and forming an air piston, ever new and always tight. The air check valve in the chamber J likewise admits air automatically, which serves to cushion the ram action of the water consequent upon the alternate filling of each of the chambers A, A.

The operation of the Pulsometer is sustained by alternate pressure and vacuum. Steam, cushioned by a layer of air automaticaly admitted, as already explained, is brought to bear directly upon the liquid in the pump chambers and forces it out through the discharge pipe; the subsequent rapid condensation of the steam, effected by the peculiar construction of the pump, forms a vacuum in the working chambers into which atmospheric pressure forces a fresh supply of liquid through the suction pipe. This action is maintained quite automatically and is governed by the self-acting, sensitively balanced steam-valve-ball in the neck of the pump, which obeys the combined influences of steam pressure on one side and vacuum on the other. The valve-ball oscillates from its seat in the entrance to one chamber to its seat in the entrance to the other chamber, serving the purpose of steam distribution with an exactitude not obtainable by hand nor possible by other mechanical methods.

It will be observed that in the Pulsometer the steam is made to do double duty by being condensed, thereby forming the vacuum, or lifting power, after it has been utilized to force the liquid out of the chambers.

These regularly recurring periods of expansion and contraction within the working chambers in conjunction with the valves arranged in their inlet and outlet ports, cause the pulsating flow of water.

The lift of any pump may be considered to be not more than 32 ft., theoretically, but seldom is more than 20 at the lowest point of the water.

Hence a Pulsometer like a pump should be set as near the water supply as convenient, but the higher it will work successfully the less the water will have to be forced.

Since the steam pressure acts direct on the surface of the water, the height to which it can be forced can be calculated thus:

Height in feet $\times$ .434 = pounds pressure on gauge,

$$\text{or } H = \frac{\text{pounds pressure}}{.434}$$

.434 is the weight of a foot of water of a cross section of one square inch.

Friction in the pipes and sediment in the water will reduce the height so that with steam at 60 lbs. pressure, we would not force water 136 feet, perhaps not over 100.

Illustrations from the Pulsometer Steam Pump Co., Whitehall Bldg., **New York City.**

AIR REQUIRED TO OPERATE ROCK DRILLS.

THE first thing to consider when about to install compressed air to operate ck drills is the number and sizes of the ills required to do the work. This ans the total number of drills that will in active service at one time.

The size of the drills is determined by e material to be drilled, whether soft, dium, or hard, together with the depth at it is desired to drill the holes.

The number of drills to use is decided the rapidity with which the work is be done, the feasibility of working ore or less drills at different points to vantage, etc.

When the maximum number to be run determined, the question arises as to hat capacity of compressor is needed to rive them. This depends greatly on the r pressure to be used, which varies om 60 pounds to 100 pounds in differ- nt plants; the lower the air pressure, the ss the amount of air required. For se at sea level, probably 80 pounds is e most common pressure at the present me. This seems to be the pressure that ves the best results under average con- tions, but the kind of rock to be drilled, nd the hardness of the drill steel, are the ciding factors. Few drills are worked onomically with air at a pressure above 00 pounds, on account of the rapidity ith which the steel dulls, and the ount of vibration, particularly in hard ck. The frequent sharpening and anging of bits greatly increases the ss of time.

The accompanying table 1 shows the ount of air required to run from one 50 Rand drills at an air pressure of 80 pounds at sea level. It is computed on a sliding scale, determined by experience, and gives the air required under usual working conditions. This means that with the increase in the number of drills used, less air is required per drill, or that there is a decrease in the percentage of the number that will be in simultaneous operation.

Table 1—AIR REQUIRED TO OPERATE RAND ROCK DRILLS AT SEA LEVEL, WITH AIR AT 80 POUNDS PRESSURE PER SQUARE INCH.

Name of Drill	Kid	No. 1	No. 2	No. 3	No. 3½	No. 4	No. 5	No. 7
Diam of Cyl. in In.	1¼	2¼	2¾	3¼	3½	3⅝	4¼	5½
No. of Drills.								
1	44	67	81	120	130	141	166	194
2	77	117	142	211	228	247	292	340
3	114	173	210	310	336	364	428	503
4	150	228	275	408	442	478	564	659
5	183	279	337	500	542	587	692	810
6	216	329	397	588	638	692	814	952
7	246	375	454	673	728	790	928	1085
8	275	418	507	750	813	882	1040	1212
9	301	458	554	820	890	964	1135	1327
10	324	494	597	884	957	1040	1222	1430
12	376	573	692	1025	1110	1205	1418	1658
15	452	688	830	1230	1334	1446	1705	1990
20	602	915	1105	1640	1775	1925	2263	2650
25	748	1140	1378	2043	2218	2400	2820	3300
30	898	1368	1655	2455	2658	2890	3380	3960
40	1195	1820	2220	3260	3535	3830	4520	5270
50	1495	2275	2750	4060	4420	4790	5640	6600

The amount of air that a compressor should furnish to run a certain number of drills at 80 pounds pressure may at once be determined from the table.

To find the air required for other pressure than 80 pounds multiply the amount given in the table by the following factors:

For 60 pounds by .789. For 70 pounds by .894. For 90 pounds by 1.105. For

100 pounds by 1.211.

The quantity determined, however, is the free air that a compressor should *deliver* compressed, and not its displacement capacity.

The figures given do not take into consideration the loss of pressure that the air sustains in its transmission from the compressor to the drills, due to friction and leakage in the pipes. In a properly constructed line, however, these losses do not amount to a great deal, and air is carried 5,000 to 10,000 feet with a loss of only 3 to 5 pounds in pressure.

As the air decreases in density with the height above sea level, more free air must be compressed at altitudes than at sea level to give equivalent results.

Table 2—FACTORS FOR ALTITUDES.

Altitude in Feet Above Sea Level	Atmos. Pres. Pounds per Sq. Inch	FACTORS. AIR PRESSURE AT DRILL. 60 Lbs.	70 Lbs.	80 Lbs.	90 Lbs.	100 Lbs.
Sea Level	14.75	.789	.894	1.000	1.105	1.211
1000	14.20	.814	.923	1.033	1.142	1.252
2000	13.67	.839	.952	1.066	1.179	1.293
3000	13.16	.865	.983	1.102	1.220	1.338
4000	12.67	.893	1.016	1.139	1.261	1.383
5000	12.20	.922	1.049	1.176	1.308	1.431
6000	11.73	.952	1.085	1.218	1.350	1.482
7000	11.30	.982	1.119	1.257	1.395	1.534
8000	10.87	1.015	1.157	1.300	1.443	1.586
9000	10.46	1.049	1.198	1.347	1.494	1.642
10000	10.07	1.083	1.236	1.390	1.542	1.695
11000	9.70	1.119	1.279	1.439	1.599	1.760
12000	9.34	1.157	1.322	1.488	1.656	1.824
13000	8.98	1.197	1.370	1.543	1.716	1.889
14000	8.65	1.2 6	1.415	1.594	1.775	1.956
15000	8.32	1.279	1.465	1.652	1.840	2.028

Having noted in Table 1 the amount of air required to run a certain number of drills at 80 pounds pressure sea level, multiplying that amount by the factors in Table 2 will give the amount which is equivalent in effect at various altitudes, either at 80 pounds, or at 60, 70, 90 or 100 pounds pressure.

For an example, assume that we wish to run six No. 3 drills at 10,000 feet altitude, and at 90 pounds pressure. From Table 1 we see that they require 588 cubic feet of free air at sea level when running with air at 80 pounds pressure. From Table 2 we find the factor for the conditions given to be 1.542; hence, the amount of air required is 588 × 1.542 = 906 cubic feet.

*Written for *Mines and Minerals*, by F. M. Hitchcock, M. E.

On the Big Canal.

Number on pay roll, 23,000.

Shiploads Jamaica negroes arrive.

Wages thrice that in Jamaica.

Only digging yet is on old French work.

Laborers' houses and hospitals well on the way.

Probably half of machinery ordered has arrived.

Health Officer Gorgas says yellow fever skeeter is destroyed.

Double tracking Panama railroad to carry dirt away.

Jamaica negroes hate whites, and jostle them on street.

Panamans becoming offensive in their sovereignty over canal zone.

Steel Outlook.

Demand for tubes immense.

All locomotive works enlarging.

Structural and rail mills have biggest run in history.

Orders for 550,000 tons building shapes in last sixty days.

Pig iron supply inadequate for steel demands.

Steel rail contracts at rate of 50,000 tons a week.

Sheet and tin mills eating up billet supply to the minute.

Biggest export demand for steel products in years.

Southern orders far [illegible] steel double four years.

IMPROVED MACHINERY.

Coburn Trolley Track System.

The round trough "trolley tracks" of the Coburn Mfg. Co., Holyoke, Mass., as shown in Fig. 1, illustrates a departure

Fig. 1.

in the design of that portion of traveling systems. Fig. 1 is full size of size No. 1 and is used for loads up to 300 lbs., No. 2½ for loads up to 500; No. 4 for 6000, and No. 5 up to 14000 lbs. The trolleys or carriers are built as shown in Fig. 2 but for large loads; these are arranged in two or four to a set, connected by means of suitable bars.

Fig. 3

Fig. 3 shows the track system with a portion used for an overhead scales.

Fig. 2.

The Bagley Graders.

Power scrapers operated by cables and engines have been employed in a number of cases for grading and excavation work.

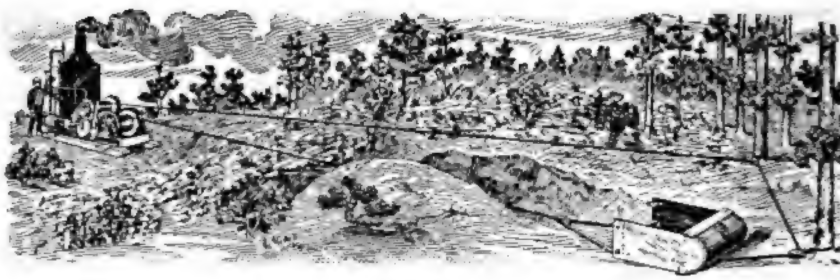
They have proved successful in regard to both the cost and efficiency of the work performed.

The one illustrated has a box-shaped bucket or scraper of ⅜" or ½" steel plate fitted with a triangular bail.

To the bail is attached the 1" steel hauling cable, and to

a ring in the rear is fastened a $\frac{7}{8}$ in. back haul rope, both ropes being carried as shown to the drums of a hoisting engine.

The back haul rope is passed through blocks fastened to trees or deadmen and the direction changed by shifting the sheaves.



The three-yard scraper is 6 ft. long and 2 ft. 6 in. deep with two knives, each 5 ft. 6 in. long. These are arranged so that when one becomes blunt, the scraper can be reversed and the work continued.

A 6-yard scraper is 8x7x3 ft. with knives 7 ft. 6 in. long. The smaller one requires an engine 9¼x10" while an engine of 10x15 is needed for the larger one.

It is claimed that the machine can handle any soil even with boulders not exceeding 20 in., and that it is not necessary to plow the ground since the knives are arranged to do the duty of the latter implement.

The machine was originally devised to reduce the cost of construction of the Tacoma Eastern Ry., where the lowest outside bid was 35c per cu. yd., while with this machine the cost was from 5 to 10c per cu. yd.

With this machine and a crew of five men, they did the work of 15 to 30 scraper teams. It is also used for loading ballast, a 60,000 lb. hopper car being filled in about 3 minutes with a haul of 300 ft. The machine is built by the Bagley Grader Co., Tacoma, Wash.

Hoist for Veneer Blocks.

For handling the short logs or blocks used for making veneer, a sling is most convenient, as shown in this illustration.

The track is hung directly over the veneer cutting machines, and runs back into the steam room, where the logs are placed for some time.

The capacity of the hoist should be about 50 per cent. more than the weight

of the largest log the machine will accomodate, unless it is to be used to handle parts of the machine itself.

Biggest contract ever made—Steel trust leases Mesaba ore lands from Great Northern railroad for $1,250,000,000.

INDUSTRIAL NOTES.

American building materials are want-[illegible] in Egypt.

Firms in Norway desire to sell American desks, etc., and they are also wanted [illegible] Austria.

[illegible] are not popular in Spain; an [illegible] representative seldom fails to [illegible] a good trade.

Sweden is making experiments with a [illegible] track electric railway, with a view [illegible] adoption [illegible] the government lines.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] manufacturers [illegible] agreement to control the markets of Belgium and Holland.

The cut of lumber in the Canadian province of Ontario will exceed that of last year by [illegible] feet. The cut will total about [illegible] feet.

Present indications are that the coming spring will see a very unusually heavy demand for refrigerating machinery in the province of Ontario, Canada.

[illegible]

[illegible]

[illegible] United States produces the [illegible] amount of silver of any country in the world. [illegible] produced [illegible] containing from [illegible] per cent pure silver.

[illegible] along the Panama Canal [illegible] considering the amount of material [illegible] around the globe.

[illegible] the paper making [illegible] Great Britain [illegible] greater than in Great Britain.

Leipsic, Germany, is building the largest railway station in the world. Twenty-six tracks will enter it. It is to cover 920,518 square feet of ground, and will cost nearly $31,000,000.

Germany pig iron production in October passed, for the first time, the million-ton mark. The month's output reached 1,006,943 tons, a gain of 16 per cent over October last year.

The National Valve Co., Sandusky, O., which has been idle for over a year, has been purchased by E. M. Barnes of Cleveland. Parts for automobile and launch engines will be manufactured.

The United States consumes all of its annual iron output of 35,000,000 tons. England consumes 6,000 tons more than its 14,000,000 ton output, and Germany 3,000,0000 more than its 21,000,000 ton output.

A trolley line owned by the city of Genoa, Italy, has paid 6 per cent dividend for 1905, against 5 per cent for 1904 and 4 per cent for 1903. The line covers 45 miles and is capitalized at $5,000,000.

Vice Consul-General Langenheim, of Coburg, says that the Government has decided to build an 18-mile railway, connecting Eisfeld, Schalkau, and Sonneburg, the manufacturing center of the toy land of Germany.

The Singer Mfg. Co. has filed plans for the erection of a forty-story building in New York, which will be higher than all existing skyscrapers by about 300 ft. and will be about 40 feet higher than the Washington monument.

One brick-making company put out 84,260,000 bricks, with an average to the machine of nearly 3,750,000. This is the largest average, and the greatest total of brick ever made in New York state by any brick manufacturing plant.

The wrecking of buildings has now become a well defined business in the prosecution of which a great deal of capital and large numbers of men are employed. The business at once useful and lucrative, contracts being taken on a basis insuring large profits to the skilful and well equipped wrecker.

The Westinghouse Company is building twenty-five electric locomotives for the New York, New Haven and Hartford road, each costing $30,000. It is the first step toward substituting electricity for steam on this line, and the prediction is made that other roads will follow the lead within a few years.

The government of Switzerland has planned to apply electricity to all the government railway lines and to operate these lines from water-power plants, utilizing the mountain streams as a source of energy. Two experts have been sent to the United States to study electric railway methods.

Anticipating an increase in the price of British coal in the near future, the harnessing of water power is engaging the attention of Italy. There is said to be 6,000,000 horsepower available in that country. The British consul at Naples says that the annual coal bill of Italy is $40,000,000, most of which is paid to England.

According to recent statistical statements published in the Bulletin of the Commercial Geographical society of Paris, the world's production of petroleum was divided as follows: Unite

States, 15,000,000 tons; Russia, 10,600,000; Sumatra, Java and Borneo, 1,000,000; Roumania, 496,000; the East Indies 404,000; all others, 250,000.

ELYRIA, O., March 10.—It is announced that the Elyria Iron & Steel Co. will double the capacity of its plant in this city by the erection of another rolling mill, equal in size to the one now in operation. At present about 350 men are employed.

One of the Alps' railways now passes through sixteen different tunnels and over fifteen viaducts. At certain points the track is laid within solid rock, with only a few feet between the tracks and the edge of the cliff.

Looking down the mountain-side, timid travelers sometimes grow nervous, but accidents are very rare.

A building is being constructed at Bridgeport, Conn., which is unique in the fact that it contains no wood whatever. The walls are concrete, the floors are of a composition which is fire proof and the doors, window sills and frames are of metal. It is claimed that there are no methods employed that are in the least experimental.

Experiments to ascertain whether it would be worth while incurring the expense of cladding steam pipes laid in approximately air-tight stoneware pipes under ground, has been carried on at Norwich, Eng. The results showed that at a pressure of 80 lbs. for 48 hrs. it was found that unclad pipe (12 inches of 1 inch pipe) condensed 25 lbs. of water in two hours and the clad pipe 19 lbs. in the same time, showing a loss of 31 per cent, even if both pipes were in air-tight buried stoneware casings.

John F. Wallace, former chief engineer of the Panama Canal Commission, whom Secretary Taft denounced as unpatriotic when he resigned a year ago, has gone to work for Geo. Westinghouse for $50,000 a year. He will direct the construction of a large number of electric railways to parallel steam railroads in the country. It is believed that this is the work that Wallace contemplated when he resigned from the Panama Commission.

Consul Hamm, of Hull, sends the following item of news which appeared in the Yorkshire Post of recent date:

A correspondent is authoritatively informed that an important contract for supplying eight powerful six-wheeled coupled bogie freight locomtives for the Manila Railway Company has, in the face of severe continental competition, been awarded to Messrs. Kerr, Stuart & Co. (Limited), of the California Works, Stoke-on-Trent. Early delivery was an important feature in the placing of the contract with British engineers, and the locomotives are to be shortly shipped to the port of Manila.

ROME.—The important sanitation and draining works covering the provinces of Mantua and Reggia have come to an end, and at Moglia Sermide the conclusion of the task, which began in 1901, was fittingly celebrated yesterday by several thousand persons. No fewer than 6,000 men have been employed on the work. Seven hundred and fifty square kilometers, on which stood properties inhabited by over 60,000 persons, were drained by a canal. The cost of the undertaking has exceeded $2,000,000.

The ceremony of inauguration consisted of opening the lock by electric means, thus permitting the water drained from the land to flow into the river Po.

ELECTROTECHNICS.

Similarity of Laws Governing Current of Electricity and Water.

By C. C. MAISON, author of "Trigonometry Simplified."

THE fact that the laws governing what is termed (if there is such a thing) flow of electricity or current through or over a conductor are similar to those governing a flow of water through a pipe, and the units used to express in figures the properties of a current of electricity are strictly comparable to those used to express the strength of a current of water. We know there are two obvious factors required to express in figures the flow of a current of water through a water pipe, weir, or channel, as the case may be, thus: The quantity and time, likewise two corresponding factors express the factor of electricity. But here is a rather confusing point. To begin with: the real nature of the electric current, whether there be in reality such a thing we are positively and remarkably ignorant. The *Hydraulic Engineer* talks of gallons per minute, while the electrical engineer talks of amperes, which are coulombs (a certain quantity of electricity per second). It is as if a gallon per minute were called a lake.

It is evident, therefore, that the volume of the flow of either a current of water or a current of electricity will depend upon the motive force by which it is impelled. The unit of electro motive force is termed the volt, which may be compared to one pound pressure per square inch. The analogy holds still further. The volume of flow of water through a pipe depends upon the friction of the water in the pipe. This friction depends upon the velocity of the water in the pipe, the friction being more at low than high velocities. It also depends on the size of the pipe, and to a lesser degree regards its smoothness, etc. Just as the latter does a flow of electricity depend on the electro motive force, and upon the conductor offers to the passage of the electricity. Then, too, as with a pipe, this resistance depends upon the size of the conductor and its material. We see right here where analogy fails as the resistance of the same conductor is constant regardless of the volume of the electric current, provided the temperature of the conductor does not vary. A large current will heat a conductor more than a small one, and by so doing will increase the resistance. So that the last analogy does not fail. It is a universal law of all fluid motion that if the units be properly chosen to agree with one another the volume of current

$$\text{equals } \frac{\text{the electromotive force or pressure}}{\text{the resistance or friction.}}$$

This formula is at the base of the science of hydrostatics as well as of electricity, while in the former it is of very little direct use because, as aforesaid, the friction depends on the velocity of flow, and the flow and friction being jointly dependent calculations in reference becomes complicated.

Electricity, however, if the temperature be maintained throughout, the resistance is constant, and in practice the range of temperature allowable before damage ensues being small, the effect of heat on the resistance is small and the above formula becomes practical. It is, in fact, used as the base of all electric current calculations. Wl

C = volume of curr

R = Resistance, the formulae is expressed above in words, becomes when expressed in letters.

$C = \frac{E}{R}$, which may be read $R = \frac{E}{C}$ or $E = RC$. In which formulae the current is supposed to be measured in amperes, the resistance in ohms ,and the electro motive force in volts.

A mile of ordinary telephone or telegraph wire has a resistance of fifteen to twenty ohms per mile, say one ohm per hundred yards. The resistance R of a common sixteen candle power incandescent lamp is about two hundred and fifty ohms when cold, and one hundred and fifty-three ohms (approx.) when hot, which is the reverse of the case with metal conductors. As the pressure E of ninety-eight volts such a lamp requires a current C of about sixty-four one-hundredths of an ampere.

$E = RC$, or $62.72 = 98 \times .64$. The watts per lamp will amount to about 63. $W = EC$, or $62.72 = 98 \times .64$. The lamps per horse power will amount to about 12 H. P. $= \frac{746}{EC}$, or $11.9 = \frac{746}{98 \times .64}$

The current of an arc lamp of one thousand candle power will amount to five amperes or more; of two thousand candle power to about ten amperes. For continuous current the pressures will be forty to fifty volts; for alternating current it will be from 30 to 35 volts. Thus it is seen readily that an arc lamp uses up one-third to two-thirds of a horsepower. Those units reduced to unity together or, rather, if the electro motive force be one volt and the resistance one ohm, the current will be one ampere and the power one watt.

Going again to the subject of water, we have not only pressure and volume of flow per unit of time, but we have their product, viz.: power. Consider a water (pressure in pounds per square foot) or by the cu [illegible] is equal to the work done per minute in foot pounds, thirty-three thousand of which are equal to one horsepower.

Just so with electricity by the number of amperes is equal to the work done per second in watts, which is in Ohms Law $W = EC$.

Seven hundred and forty-six watts equal one horsepower. That is, a generator whose output is 746 watts of electro motive force, and operating without loss, would consume one horsepower, or a motor without loss would deliver one horsepower, which is H. P. $= \frac{746}{EC}$. The watt is, however, too small for most commerciai requirements and in consequence of which electricity is multiplied by one thousand or K. W. The only tangible unit of resistance is the resistance offered by 14.4521 grams of mercury at 0 degrees centigrade of a constant cross section and 106.3 centimeters long.

Storing of Cement.

At the close of the season a quantity of cement may remain on hand, or it may even be advisable to purchase a quantity for early spring use. In this case considerable care should be exercised in the storage. Select a warehouse or storage place which is as dry as possible, then construct a platform raised some six or eight inches above the floor and removed a short distance from the walls.

If the cement is in paper sacks or in barrels it will keep better than when packed in cloth and it is considered advisable to buy sacked cement in paper if it is contemplated to keep over winter. When the pile of cement is heavy the lower layers sometimes become hard from compression, but the quality is not injured. Cement cared for as above mentioned can be kept either in winter or summer and for months at a time.

HELPFUL KNOWLEDGE ABOUT ELECTRICITY.

By Edmund B. Moore,

Author of "Wire and Wireless Telegraphy."

PART VIII.

FROM the preceding articles the reader has obtained a general idea of the fundamental principles of electricity. Those which we constantly come in contact with in our every day life. As we advance to the higher steps of this fascinating subject we will see the application and adaptation of the already explained fundamental principles.

Today there is hardly any other subject so carefully and thoroughly studied, and yet so little known.

The laws and theories which have been accurately worked out are as familiar to us as those of light, sound, etc.

Yet electricity, itself, is as much unknown now as centuries ago, and we still go on basing our knowledge on the laws and theories thus far founded.

Beginning with this number, we are going to deal with the higher branches of our subject.

The principles, theories and laws which have been put to a practical and commercial use, showing to the reader how they are successfully applied in the operation of dynamos, motors and hundreds of other things.

I will caution you, however, before continuing further with the serial, that the elementary steps be thoroughly understood and mastered. If this is done the succeeding articles, which will deal with apparatus employing these principles, will be easily followed and much better understood.

We will now venture from the somewhat theoretical view point and take up the more practical and commercial side, beginning with Dynamo Electric Machinery.

Machinery in which mechanical energy is converted into electrical energy, or electrical energy into mechanical, by the means of electric induction, is called Dynamo Electric Machinery.

A machine wherein mechanical energy is converted into electrical energy by the means of a continuous relative motion between two electrical conductors and a magnetic field or fields, causing the lines of the field or fields to traverse or cut the electrical conductor producing the electrical current is called an Electric Generator or Dynamo.

If a machine is continuously supplied with electrical energy to a system of electrical conductors, this causing a magnetic force to act between the conductor traversed by the current and the magnetic field or fields, producing a continuous relative motion between the electrical conductor and the magnetic field or fields is called an Electric Motor.

The electric generator will be first described.

In preceding chapters we have explained how electric cells and batteries are made and operated to produce an electric current. This current, however, being very weak, would be very unsuit-

able for the use of lighting, charging and power purposes.

The electric current cannot be economically generated by a battery for any great length of time on account of the chemical action which takes place within the cells and destroys its commercial value. This point, however, has been fully explained. It is therefore necessary that some machine be made to generate a constant amount of electric current by an economical and simple method.

This is accomplished by a device called an Electric Generator or Dynamo.

A dynamo electric machine, which is so constructed that by applying to it mechanical energy the electric current is produced by induction, is called a Generator, or perhaps by a more familiar term, the Dynamo.

A dynamo does not actually create electricity. Instead it produces or generates by induction an electro-motive-force, and this E. M. F. causes an electric current to flow through a suitable insulated conductor external to the machine itself.

The principle of the dynamo is on induction. (Explained in Part 5).

By moving a strong electro magnet rapidly in and out of a solenoid, an electric current is induced in the coil. A magnetic field exists about the magnet and moving it through the coil causes the lines of force to cut the conductor and produce an electric current.

The induced current may be generated in other conductors than the coil of wire. If for any reason the number of lines of force in any conductor of a closed circuit undergo a change, small or great, the lines of force decreasing or increasing, an induced electric current will be set up in this circuit. It is not necessary, however, for the object producing the lines of force to move in every case. The conductor itself may move over or cut the lines of force from the stationary field, and the induced current will be produced in either case. All that is necessary is to have the lines of force cut the conductor, and this cutting may be done by either field or conductor.

The result is the same in both cases.

We will now take a wire in the form of a rectangle and revolve it upon its axis, between the north and south poles of powerful permanent magnets. It will be readily seen that when the wire is in a horizontal position with the poles there are no lines of force being cut by its movements. Thus, no induced current whatever, is produced in the wire. As the wire loop is turned, both halves of the loop will at once come into the field of force caused by the magnets between which it is being rotated. In one half of the loop the number of lines of force being cut will increase, and an induced current will be produced in this half in one direction, but through the other half the number of lines will decrease, thus causing the induced current to flow in exactly an opposite direction. The induced current in the two halves is produced by the increasing and decreasing of the lines of force as the wire is rapidly rotated from the position where there were no lines being cut, as when the wire is perpendicular and horizontal. During one revolution of the wire a current is produced that first flows in one direction, then in the other.

This alternating current produced by the rotation of the wire through the field of force will flow in one direction during one-half of a revolution and in the opposite direction the remaining half of the revolution.

To make this alternating current available for use, some connections must be made to allow the current to flow from the wire. This is done by connecting the

two ends of this wire to two brass or copper rings mounted upon the shaft. These rings are insulated from each other and also from the shaft itself, by some good insulating material, usually hard rubber or a specially prepared compound. Bearing upon these two rings are copper brushes which press sufficiently upon them to assure a good electrical contact as the rings turn with the wire and shaft. The brushes are mounted stationary and connections to the external circuit are made from binding posts connected with the further end of these two brushes.

These rings, through which the electricity from the revolving wire is collected, are called Collecting Rings.

When the electric current is generated by machines employing the above principle there is a large amount of mag-

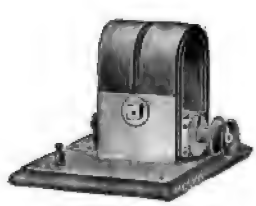


Fig. 35.—Magneto.

netic force emanating from the permanent magnets that does not pass directly through the revolving wire. This loss tends to lower the efficiency of the machine as to its maximum output.

To avoid all possible loss of the lines of force from passing through or cutting the conducting wire, it is wound upon an iron core or Drum. Wire so wound upon a core or for the purpose of causing an induced current by its revolving through the magnetic field between the poles of powerful magnets, is called an Armature.

This particular kind of armature is known as the Siemens armature after the inventor, Sir William Siemens.

Siemens was an eminent inventor, engineer and natural philosopher. He was born at Lenthe, in Hanover, on the 4th of April, 1823. As a promoter of applied electricity, he is in the front rank and his name is associated throughout the engineering world at large.

We have explained how iron has much greater permeability than air, so by substituting iron for the air space in the armature, it causes all the lines of force to pass through the wire upon it.

The E. M. F. of the current generated depends upon the number of lines of force being cut in a unit of time. The rate at which the lines of force, produced from the magnet are cut, depends upon the penetrating strength of the magnetic field, the length of the conductor upon the armature, and the speed at which this is revolving.

If a conductor one centimeter in length is revolving across a magnetic field at the rate of one centimeter per second and this magnetic field has the strength of one line per square centimeter, the difference of potential in the circuit will be one volt. Or if a conductor cuts 100,000,000 lines of force per second as it revolves through a magnetic field, there exists between the terminals a difference in potential of one volt.

In the above armature only a single wire was used and from this last statement it will be readily seen that by increasing the number of turns of wire a much greater number of lines of force will be cut, even if the other conductor remains the same. This is exactly what is done, and in the drum armature a large number of turns of wire are wound upon the soft iron core, thus allowing a much greater number of lines to be cut by the magnetic field from the pole pieces. This increases the E. M. F. and the efficiency of the machine.

It will be noticed that the electricity

which is produced from this style machine and collected by the two brushes upon the rings, is a pulsating or alternating current. It is necessary in many cases where electricity is used to have a direct current available. In fact, it would be impossible to charge storage batteries or the like, direct, with the use of the alternating current.

To produce this direct current from the electric current induced in the revolving drum armature what is called a Commutator is used. This is somewhat like the collecting rings, but instead of using two separate rings two segments or blocks of copper are employed, these running lengthwise with the shaft, one on each side. In this machine where two coils are used the commutator will be divided into two parts and each insulated from the other by some good durable insulator. This commutator is placed at one side of the armature coil and the two ends are connected to each segment respectively. The brushes bear upon the segments as they revolve with the armature. The brushes are placed opposite each other and in such a position that they both bear upon their respective segment. As the armature is revolved, the alternating current induced in the internal circuit of the armature will be lead off by these brushes in one direction. That is, the segments are so arranged that they will change their contact with their respective brush as the induced current reverses in the coil and the coil itself at this point will be in a vertical position. The current flowing in this external circuit will be in one direction, or what is called a Direct Current. It will, however, pulsate as the armature is revolved between the poles of the field magnets.

In this two-coil armature the pulsations in the external circuit will be very noticeable and a machine thus equipped is of value for only telephone and line testing work, being made on a very small scale compared to the commercial machines.

Also, when a machine of two coils equipped with a two segment commutator is to be used at a heavy pressure for power purposes, trouble is caused by the brushes sparking at their contact with the rotating commutator.

To overcome this disadvantage in constructing large machines and also to produce a much steadier current a number of coils are distributed over the armature, each being connected exactly as in the two coil armature.

That is, a large number are used and each coil is arranged so that they will all be electrically connected with each other.

Fig. [illegible]—Small Dynamo (Shunt wound).

At the union of each coil, connections are made with the segments upon the commutator. If a four coil armature was used that would mean four segments in the commutator, one for every coil.

To avoid eddy currents in the armature it is usually made of a large number of metal disks stamped out and pushed firmly together. Each disk is dipped in shellac or separated from the next by a light, thin sheet of paper. In this way the local currents, which are sure to occur in the solid core, are in some respects

done away with. Armatures so arranged to avoid eddy currents are said to be Laminated.

The Gramme's armature which is generally used in the up-to-date machines, is made in the form of a ring and is often called the Ring armature. The first Gramme armature to be successfully employed was used by its inventor in the year 1870. Each coil is wound about this ring, which, to avoid eddy currents, is made similar to the core of the drum armature. The connections of each coil to the commutator are the same as before.

In very large machines the number of coils upon the armature is usually greater and the direct current produced in the external circuit will be pulsating, but so very rapidly that it will hardly be perceptible.

The invention of the electric magnet was a great aid to the advancement of modern dynamo-electric machinery. In the place of the heavy permanent magnets, which were used in the experimental stages of the dynamo, the light powerful electro magnets have taken their place. Instead of depending upon the natural magnetism which is contained in the permanent magnet, an electric coil is wound about the legs of the field and by passing a current through it produces a very strong magnetic field, much stronger than could possibly be produced with the old type.

The current which is used to magnetize or excite these field magnets in the direct current machines is taken from the armature. The field coils may be either connected with the armature in series, shunt, or multiple. It may seem strange at first thought to obtain the exciting current from the machine producing the electricity. But nevertheless, this is what is done. When the machine is first started there is always a slight trace of magnetism in the field and this is utilized to generate the first weak electric current. This slight magnetism which is always retained in the limbs of an electro magnet is called Residual Magnetism. As the machine gradually gains speed and the current increases, the current passing through the field will also increase until the machine is at running speed and the magnetic strength of the magnets reaches its maximum.

If the machine is what is called a Series Wound Dynamo, all the current generated by it will pass through the wire around the field core. The field winding in this case being connected in series with the external circuit.

If it be a Shunt Wound Dynamo, only a portion of the current generated by the armature passes through the field wire, which is made up of a greater number of turns. The field windings in this case are connected to the armature in parallel or shunt.

With the Compound Wound Dynamo the main current produced is made to pass about the field through a heavy wire. Also a current shunt from the armature passes through a small wire about the same fields. This compound method is practically a combination of the series and shunt windings. A great many advantages are given with a compound wound dynamo. The machines so constructed, are very self regulating and for this reason are used for incandescent lighting and power purposes.

With an alternating current machine what is known as an Excitor is used to generate a direct current for the magnetization of the field magnets.

An alternating current dynamo cannot, whatever, excite or magnetize its fields from the electric current generated by its revolving armature.

The excitor for these alternating current dynamos is practically a small di-

rect current dynamo of about 210 volts. This is driven by a belt from a pulley placed on the armature shaft upon the opposite side from the main driving pulley. As soon as the armature of the dynamo revolves, the excitor will generate a direct current which is allowed to pass through the fields by which they are magnetized.

If the machine was started rapidly and the field current of the dynamo, no matter how connected, was allowed to pass suddenly through the field wire, it would cause the magnets to overheat and damage the insulation of the machine.

To guard against throwing a strong electric current suddenly into the field, what is known as a Rheostat is used. This consists of a very large amount of resistance connected in the circuit, and by the moving of a metal handle this resistance may be cut slowly out of the circuit, allowing the current to gradually increase in strength.

The resistance coils of these rheostats are made of German silver wire and are wound into long coils, these being placed neatly on an insulated frame and usually covered by an insulator such as marble, slate, etc.

All the coils are connected with each other in series and at the union of each is a wire running to brass blocks on the face of the instrument, over which the lever passes. By simply moving the lever, which is also connected in the circuit, the complete resistance may be inserted or only partially so.

The large alternating and direct current dynamos which are used in our large modernized plants, are nearly to the stage of perfection and are constructed in many styles, shapes, and sizes. The style and size of the machine depends wholly upon the use it is to be put to and the power by which it is to be driven.

In all dynamos, however good the construction and designing, there is a somewhat loss of power. That is, the current of the external circuit of the dynamo is less than the power which is used to drive it. There is a small amount of power loss in the dynamo windings, as resistance overcome eddy currents which tend to increase the resistance of the armature's rotation through friction upon the moving parts; and the effects of Hysteresis, or the amount of power lost by the generation of heat which warms the dynamo and is unavoidable to a certain extent in all machines.

Fig. 57—Rheostat

The amount of heat generated in any dynamo depends upon the rate that the armature is turning, the strength of the magnetism of the field and the quality of the iron in the field and also that of the armature.

In a well designed machine these losses are and should be very small. Consequently the power loss is only a trifle.

The commercial efficiency is less than the electrical efficiency on account of the above losses. The commercial efficiency of any marketed machine, those accepted as standards, to produce the best results, should not be less than ninety per cent.

The uses to which the alternating and direct current dynamos are put are many. The most important are for furnishing the electric current for lighting and power purposes.

Fig. 38—Drum Armature with Commutator.

One of the greatest power stations in the world is situated at Niagara Falls. The alternating current dynamos or Alternators as they are often called, weigh eighty tons each. These huge machines are all installed in rows and are each driven by a turbine water wheel which revolves the armature. The shaft of the turbine answers for that of the alternator. The water which operates the wheels is led to the station through a long tunnel and has a fall of one hundred and forty feet. This drives the armature at the rate of two hundred and fifty turns per minute. There are a number of these alternators at the plant and each produces a current of 5000 H. P. So perfect is the design and operation of these machines that the commercial efficiency is stated at about 97 per cent.

The power from this plant is mostly transmitted to the city of Buffalo fifteen miles away. The loss in the transmission is about 10 per cent. The power for the millions of electric lights at the Pan American Exposition was supplied by this station.

The Buffalo street cars and a large number of the mills are entirely dependent upon the Falls to furnish them with electric power.

The construction, operation, and uses of the electric motor will be carefully considered in our next chapter.

(To be continued.)

QUESTION BOX.

(This department is in charge of Mr. A. B. Babbitt, Hartford. Conn., and questions will be answered more promptly if sent directly to him. The department is intended to give correct answers to questions of general interest. Make your question complete. Name and address must accompany each query, although neither will be published.)

1. Can a gas engine spark device be operated with alternating current?

We presume your question refers to the application of the alternating current to the ordinary make and break device as designed for direct current. Under these conditions we do not believe the change would be a success. The alternating current is constantly changing in value except at the time instants of maximum and minimum value. The lines of force due to this current are also changing in number, hence the induced e. m. f. is changing. Should the circuit be broken when the primary current is at its maximum, there would probably be a condition similar to that occurring when direct current is used, but it would hardly be possible to have the break occur each time at the instant of maximum value.

DRAFTING DEPARTMENT.

System in a Drafting Room.

In a large engineering office employing g..d force of men, it is important that rerything be gotten down to the most r.ductive basis and every avenue of xpense must be guarded by effective .stems of accounting.

Our readers may be interested to learn .w some things are done at the Brown l.isting Machinery Company's offices.

The form of time card used by the mployees is shown in cut No. 1. Each ay one of these cards is filled out by :e draftsman, giving his clock number, boys to do the running that would otherwise waste a large portion of their own time in going after supplies, drawings for reference and so on.

The system for the filing and use of the record drawings in the safety vaults is very interesting. There are two large fireproof vaults, fitted up with more than four and five hundred drawers respectively. Each drawer is of a size to receive a standard drawing sheet 24 x 36 inches and is 3 inches deep and designed to hold the drawings for a single contract, or more than one contract where

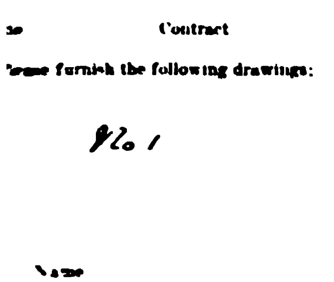


Fig. 2.

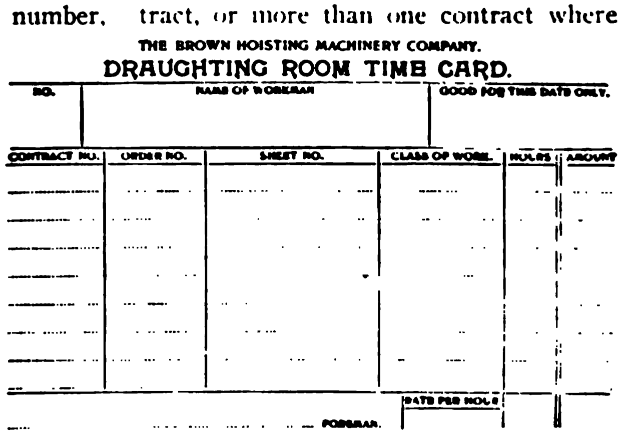


Fig. 1.

..e and date, and underneath are :ven data from which clerks in the office xtend and mark up the time on the acks of the vouchers which will accompany the month's pay, and charge up the me against the drawings indicated and :stribute the expense to the different ab-orders on contracts or work.

In the drawing room everything is one to facilitate the geting out of orking drawings.

Annunciators are hung over each table o the draftsmen can ring for the office the same drawings are used and marked up for other and later contracts.

Cut No. 2 shows the form of card used in applying for a sheet number for a new drawing.

The head vault-keeper has an entry book for keeping record of the drawings as he gives out serial numbers for them.

This card is filled out by the draftsman with information full enough for thoroughly indexing the drawing, both in the entry book and the card index. The vault-keeper assigns the sheet number

and makes entry in his book of the description given on the card. This application must first be countersigned by the squad foreman as a check to prevent mix-ups and taking out unnecessary numbers, and to see that the title is descriptive.

The stub on the end of the card Fig. 3 is filled out and returned to the draftsman, who must see that the number and title are entered on the index kept by the squad foreman, for each contract.

When a draftsman wishes to use a drawing for reference, he fills out the card shown in cut No. 2 and rings for a boy to bring the drawing.

by each squad foreman, each evening, at the close of the days work and these various envelopes are taken into the vault for the night and returned to the squad foremen early next morning.

Each Saturday afternoon every drawing must be filed in its proper place in the vault, and if the men need them for further reference, they must keep a record of the sheet numbers wanted and draw them again on Monday morning as though they had not had them before.

In this way a most effective check is kept on the movements of each record drawing, of which there are now nearly 60,000.

DATE.	Tracing Blue Print Sketch or Form.	Cont. or Order No.	Drawer Number.	Original Tracing in Drawer No.

Sheet No.................................... Squad....................

Description..

....

....

Name...

Sheet No..................

Name..........................

Fig. 3.

A little cast iron holder or pocket is fastened to the front of each drawer for holding these cards, which are kept there until drawing is returned and filed, after which the card is destroyed.

A man can call for any number of drawings for the same contract on a single card, or can draw the sketch envelope,—or the whole drawer,—in which case the card shows where the drawer has been taken.

No checked drawings are allowed to remain outside of the vault over night, and so all original record drawings used by the men during the day must be placed in the envelope or portfolio kept

There are many other things of interest at the "Brown-hoist," some of which may form the basis of future articles in this magazine.

Design of Cam Driver Brakes.

By "Railway."

RULE FOR DRIVER BRAKE LEVERAGE.

From weight of engine on drivers, deduct one-fourth, provided this amount is not less than 9,000 lbs. nor more than 12,000 lbs., governing deduction by weight of engine. Divide this remainder by two in order to obtain constant for one side of engine, and divide this quotient by 2,500 if an eight inch air-brake

cylinder is used and by 1,400 if a six inch cylinder is used. The result will be the required leverage.

Example:

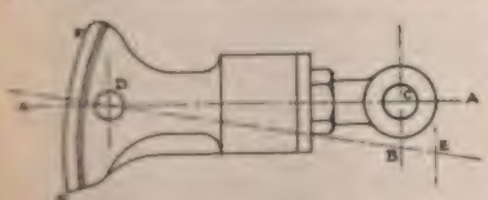
Weight on drivers..........40,000 lbs.
Deduct one-fourth ....10,00 lbs.

Remainder ....30,000 lbs
Divide by two.......... 2 | 30000
One side of engine....... 15000
Divide by 2,500, constant 2500 | 15000
for 8 inch cylinder. 6

The required leverage is six, and assuming the length of the cam to be 12 inches, if we divide 12 inches by the required leverage six we get a 2 inch offset from which to draw the face of the cam.

TO LAY OUT ARC OF CAM.

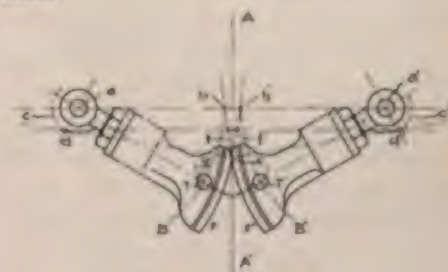
In Fig. 1, D is the link pin in cam and C is the cam screw pin. Having determined upon the distance between these two centers, draw the line B C perpendicular to the line of centers A A' and lay off on this line a distance equal to



the length D C divided by the leverage. In the problem at hand we took 12 inches as the distance from D to C, found the leverage to be 6, giving the offset 2 inches. This makes the distance B C 2 inches.

If the face of the cam F G is struck from center B, the cam will give a leverage of 6 to 1, but as the brake shoes wear and adjustments of parts are made to compensate for this wear, the distance between C and D will be increased consequently increasing the leverage to a ratio of more than 6 to 1.

To allow for the adjustment of the cam screw and at the same time to keep the leverage below a ratio of 6 to 1, the curve of the cam face is struck from a center located on the line but with a radius greater than the distance B D. In Fig 1, the curve F G was described from center E. Referring again to the proportions for our problem if the distance B E was made 1½ inches the distance from D to C could be increased that amount without making the leverage more than 6 to 1. To be sure the leverage at first would be less than 6 to 1, but the object is not to increase it beyond that ratio.



TO LAY OUT A PAIR OF CAMS.

Knowing the distance between drivers, locate centers of cam screw pins at aa' bringing brake shoes ½ inch from face of drivers. Draw center line aa' and lay off each side of the perpendicular bisetor A A' points b and b'. The distance from the center line A A' to the points b and b' should equal the distance B E (Fig. 1) minus the distance brake shoe is located from face of drivers. In the problem used for our example, we would have 1½ inches minus ½ inch giving the distance from center line to b and b', one inch. The points a b and a' b' give the approximate lengths of cams on which to base our calculations for the offset.

From centers of cam screw pins, a and a', draw the arcs b B and b' B', also the arcs c and c' with radius equal to the required offset. With a as a center and radius, equal to the distance from a to b' draw arc f' and with a' as a center and a' b as a radius, draw arc f. These arcs

will intersect A A′ at K, which is the position of the upper corner of the cam. With K as a center and radius equal to the distance from K to the center line a a′ draw arc g intersecting arcs b B and b′ B′ at T and T′. These points T and T′ will be the centers of the link pin.

Draw center lines a T and a′ T, and make a d, and a′ d′ perpendicular, respectively to these two lines, and where these lines intersect the arcs c and c′ will be the centers of the cam faces. With d and d′ as centers describe arcs F and F′ through K, which will be the curves of required cams.

The distance from the center of link pin to face of cam should be, where practical, one and three-quarter inches measured on the center line: should this measusement be incorrect, change the position of pin on center line and work back to the points b b′. Should this materially change the length of cam, make a new calculation.

Keeping a Record of Sketches Sent Out.

Many times sketches are needed in a hurry. It does not pay to make a finished drawing and then wait for the blue print, nor does it pay to send the sketch into the shop without having a record of the same in the drafting room.

The best way for recording these sketches is to use a letter copying press and book. Make the drawing with copying pencil, to scale on cross-section paper if you please or simply free hand, and then make a copy in copying book. This book, if properly indexed, will keep a complete record of all the sketches.

DON BETA.

Drafting Appliances.

I am using some useful articles on the drawing board which I have never seen illustrated. Possibly descriptions may interest your readers. Sometime ago I obtained a two foot rule that had been discarded by a carpenter because the graduations had worn off. The hinge was in a good condition and it occured to me that it could be made into a protractor. I made one as represented in Fig. 1 and

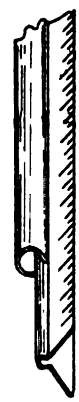


FIG. 2

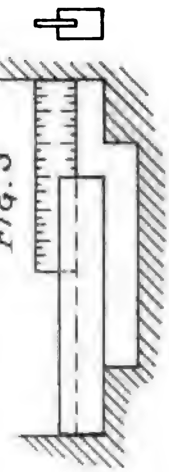


FIG. 3

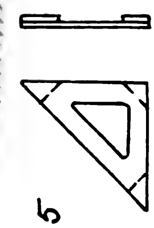


FIG 5

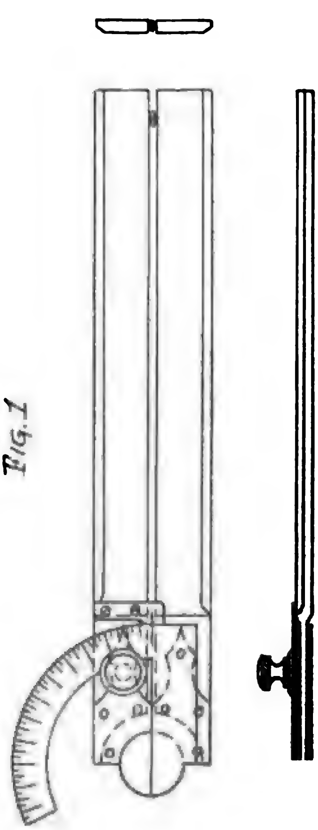


FIG. 1


FIG. 4

have been much pleased with it. I took out the 12 inch rules and riveted in their places two wooden strips ¾ inch wide by 8½ inches long. Their outside edges were beveled and made parallel by inserting a screw in the inside end of one of the strips. I then removed the head of a machine screw and filed a square section, and drove same tight and soldered to hinge. I procured a protractor and cut away a portion of it, the remaining piece which was 115 degrees space of 25 degrees left to clamp nut too was soldered to hinge.

The pointer was then placed in position and a washer and thumb-nut completed the tool.

It will be noticed that either edge can be used, as the graduated portion is raised, which allows it to clear top of tee square.

More or less trouble was experienced in picking up the draftsman's scale as manufactured by Brown & Sharpe Mfg. Co. To overcome this I took a piece of brass tube ⅝ inch diameter by 5 inches long, slit it the full length, the slot being a little thinner than double thickness of scale. Had the tube plated and sprung it on scale as shown in figure 2.

In figure 3 is shown a very handy tool which I call a scale extension. It is a wood or metal strip rectangular in shape and of any known length, with a groove its full length.

Through this a scale can be pushed for measuring distances greater than 12 inches, and where a longer scale would be inconvenient. Different lengths of these strips could be made and used to good advantage.

When sharpening the lead in Faber's artist drawing pencil by the usual method, on a file, the sleeve of the pencil is gradually filed away. To overcome this a piece of steel is soldered to the end of the sleeve as shown in figure 4, which lengthens the life of the holder.

When tracing separate pieces it becomes quite tedious waiting for the ink to dry before inking lines in the opposite direction.

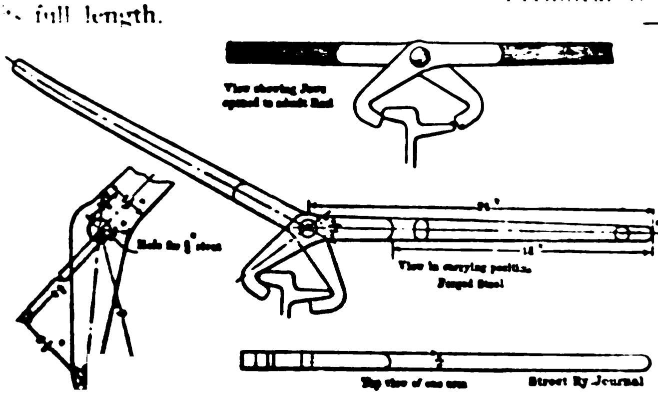
An angle as shown in figure 5, having pieces of cardboard or other material glued to it, is very handy when one is extra ambitious.

Bridgeport, Conn. C. E. JOSSELYN.

Lubrication of Wire Ropes.

Question: Is it advisable to galvanize wire ropes subjected to constant bending around sheaves and drums?—*C. G. N.*

Answer: Such ropes are not usually so treated; but it is essential that they be kept well lubricated by the frequent application of oil, or some similar material, free from corrosive substances. A good waterproof graphite grease gives satisfactory results as a lubricator.—*Technical World.*



Standard Rail Tongs.

The illustration shows a design for tongs for handling rails by hand given in the *Street Railway Journal.*

CURRENT TOPICS.

Questions and Answers.

This month we have opened a Question and Answer department in our magazine and trust it will be found useful and instructive to our subscribers and readers.

When sending in queries, write on one side of the paper only. No questions will be answered by mail, but will be published in due time.

Name and address must accompany each question and no attention will be paid to anonymous requests.

This department will be in charge of Mr. A. B. Babbitt and communications may be sent directly to him at 611 Albany Ave., Hartford, Conn., or in charge of this magazine.

It is for the readers to make this column a success. Send in your questions.

How Jobs Are Lost.

It is always interesting, of course, to learn how young men and boys get jobs and hold them, and how they rise from lower to higher positions and increased pay. It ought to be equally interesting to learn how some employees lose their jobs. The *Chicago Tribune*, with this end in view, not long ago offered a weekly prize of $5 for the best explanation, by letter, of how a job is lost. There were eighty-one competitors, most of the letters containing frank confessions of the writers' shortcomings. The reasons assigned for discharge were as follows:

Drink	11
Loafed	9
Bad company	7
Carousing unfitted them for duty	7
Swelled head	6
Business discontinued	4
Accused of gambling (one guilty)	4
Aspired to get higher jobs	4
Refused to run errand	3
To reduce expenses	3
Accused of drinking	3
Cigarettes	2
Shirked work	2
"Knockers" got busy	2
Because he wanted to learn English	1
Called on girl while on duty and lied about it	1
Because the beer froze	1
Thought business couldn't run without him	1
Gave the boss the wrong tip on a race	1
"Kidded" the boss	1
Cheated to keep up with heavy work	1
Didn't work unless specifically told to do something	1
Offered to box with priest	1
Wanted to marry boss's sister	1
Boss boorish to women clerks	1
Couldn't understand when owner dictated in broken English	1
Forty year old stenographer wanted to marry him	1
Manager's wife disliked him	1

As might have been expected, drink was the one single cause assigned for the largest number of discharges—eleven—although "carousing" that unfitted the carousers for duty was responsible for seven lost jobs. And it is to be noted also that only eight of the eighty-one who were "fired" blamed their employers for it.

u Worth Your Salary?

earn your salary? Are you
itisfied that what you render
an equivalent for the amount
ou receive?
you are getting $1,500 a year,
fident that you are worth it?
stion is ticklish and touches
e are more or less sensitive.
s the smaller the amount of
more likelihood there is that
ly earning it.
salary carries with it no in-
nd is more within the reach
rning power. The generality
to work to live, and the gen-
eople get small salaries.
a clerk plodding along daily
e of duty, that is his second
f knowing just exactly what
do every year, and he is apt
notes.
work that he turns out faith-
conscientiously, and then he
small salary.
s he is worth more than it
He knows very well that if
hrow up his situation there
difficulty in filling it.
nscious that he is worth all
and something more.
we are rendering a dollar's
rvice for every dollar of
hould be satisfied with our-

ake yourself uneasy about
If you are getting what you
d you are sure that you are
you are getting, why,
ched a state of contentment.
come a time when you are
than you are getting. Make
Make your work stand out
that it will convey this im-

very dull employer that will not see this after a time. If he persists in not seeing it, why, then, you are justified in calling his attention to it.

Do not presume to do this until you are confident that the coast is clear for this kind of sailing.

Large salaries tend to make some more important than they really are. To be all salary, and to be commonplace in your work, requires a dead conscience.

One hundred thousand dollars a year may mean only $50,000 worth of service, and may not mean that. At any rate, this interpretation was recently placed upon that kind of salary. You cannot judge a man's worth by his salary. You may determine his pull by it.

But giving in service what you get in salary makes anyone independent of any obligation to his employer.

Good wages, if they stand for good, substantial work, are just.

Small wages for good work mean imposition.

BOOK REVIEWS.

"Are you good at lettering?" is the question asked of a large per cent of applicants for positions as draftsmen, and only a lot of practice and good copies will effect the result desired.

Of the many books on the market, no one contains as much matter and good forms as a "Chapter on Lettering" by the Browning Press, Collinwood, O. Price 25 cents. Send for a copy at once.

Compressed Air announces that with its issue of May it will appear in enlarged form and under new management. Hereafter it will be published by The Kobbe Co., 90-92 West Broadway, New York. For ten years *Compressed Air* has been, and still is, the only publication devoted exclusively, and covering completely, the field of

compressed air in all its applications. This field, however, has broadened so materially within the last few years, that a more comprehensive periodical is needed to fully meet the new conditions. With the May number, therefore, the size of *Compressed Air* will be changed to 7 x 10, it will be printed on better paper and in outward form will be on a par with the best printed magazines now published.

A special feature of the paper will be a department devoted to corespondence, a discussion of which will be encouraged among its readers. But probably the most valuable information will be contained under the heading, "Practical Items for Practical Men," where data of direct and practical value to compressed air users will be discussed.

Mr. W. L. Saunders, M. Am. Soc. E. E. will remain as Editor-in-Chief, W. R. Hulbert, M. E. will be Managing Editor and P. F. Kobbe, Jr., will be Business Manager. Contributions and correspondence from those interested in the uses and development of compressed air for industrial purposes will be gladly received and made use of if acceptable, and requests for information will be given prompt and courteous attention. All subscriptions and correspondence in future should be addressed to The Kobbe Co., 90-92 West Broadway, New York.

The following list comprise the data sheets now in stock which were issued with *The Draftsman* and *Browning's Industrial Magazine:*

Rivet Spacing.
Conventional Rivet Signs.
Morse Tapers.
Section Lining.
Good Proportions for Keys.
Dimensions of Standard Washers.
Bosses for Washers and Bolts.
Eye Bolts.
Weights of Various Substances.
Turn Buckles.
Standard Rail Sections.
Beams Supporting Brick Walls.
Pipe Sizes.
French and American Equival Measures.
Clearances.
Gas Piping.
Foundation Anchor Plates.
Sheet Iron Ventilators.
Gray Iron Machine Hand Wheels.
Limit of Caulking Pitch in Boi Work.
Tables for Permissable Stresses.
M. C. B. & P. R. R. Standard Angl
Compression Tests of Concrete.
Standard Hand Wheels, Heavy.
Dimensions of Wrought Iron Washe
Dimension of Bonanza Grease Cup.
Plugs and Pet Cocks.
Bolts and Machine Screws.
Trigonometric Functions.
Elements of Cast Sections.
Numbers and Equivalent Diameters Machine Screws.
Lacing.
Brass Key Heads.

All of these with a suitable binder w be sent as premium for one new su scriber to *Browning's Industrial Mag zine*, at $1.00. Address Collinwood, (

Building Construction and Superinte dence. By F. E. Kidder, C. E., P D., Architect, Fellow of American I stitute of Architects, Author of "T Architects' and Builders' Pock Book." Part III.: Trussed Roofs a Roof Trusses. 306 illustrations. Se tion I. New York: William T. Co stock. One large 8vo. vol.: pp. 2 Price, $3.00.

This work is the las .e series "Building Constructior . Superint dence" from the han Kidder a

g work of his life. It is a work ad been engaged on for years. in the profession have had the erience he has had in practical this character.

:w of its pages shows a careful :ientious discussion of the sub- that in clear language, uncom- by mathematical formulas that l only to the engineer. Simplic- :horoughness, clear description explanation are the character- the treatise. This section car- ubject for enough to meet the most architects and builders. the second and last section is out and will later be completed ished.

llowing subjects are treated in before us: "Types of Wooden and the Mechanical Principles ": "Types of Steel Trusses": of Trussed Roofs—Bracing of and Trusses"; "Open Timber d Church Roofs": "Vaulted ned Ceilings, Octagonal and Roofs": "Coliseums, Armories, ls, Exposition Buildings, Etc.": ng the Purlin and Truss Loads orting Forces": "Stress Dia- d Vertical Loads for Trusses cally and Unsymmetrically

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finition given in "Lutes and " a booklet by the National . Cleveland, O., is as follows: Clay or mixtures for closing

- Substances with which two joined together.

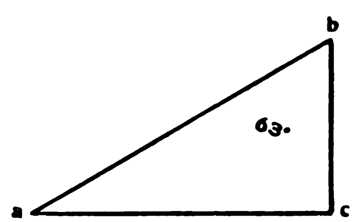
eipts are concise, but not made erials that are unobtainable as e case with such formulæ.

oklet is divided into "Water a Proof, Oil Proof, Acid Proof, Proof to Hydro-Carbon Gases, Chlori Proof, for general purposes, such as elastic, gaskets, machinists, marine glue, leather, core compounds, crucible iron and stone and briquetting."

Price 10c. National Book Co., 408 Park Bldg., Cleveland, Ohio.

No branch of mathematics is so little understood and greatly feared by the average workman as trigonometry, yet it is a subject not hard or tedious.

When we see the uses to which this branch may be extended, there is no reason why every mechanic should not try to master it.



Trigonometry is really devoted to the solutions of triangles, either to find the lengths of sides or the size of angles.

Suppose we had a triangle like the illustration and knew the length of a side and an angle under certain conditions we could find all the other parts.

To aid in the practical application of this subject, Mr. C. C. Maison has written "Trigonometry Simplified," which is a neat little book with many illustrations and tables. Price in cloth, 50 cents.

These books, while delayed, are being published by the National Book Co., 408 Park Bldg., Cleveland, O.

The first passenger elevator or lift to be used in this country and perhaps the world was placed in the Fifth Ave. Hotel, New York, in 1850.

A hairdresser, as a rule, does a thriving business in combination locks.

Past, Present and Future of Reinforced Concrete as a Building Material.

Only a few years ago, the method of reinforcing concrete structures with steel bars was almost untried. It is hardly more than five years since some of the railroad companies began to replace their old wood and iron bridges with concrete steel arches.

The natural forests of the country are rapidly disappearing and the price of lumber is going up by leaps and bounds, some kinds having doubled in value in a few years. Steel is expensive and is destined to become more so, and with increased demand on the mills, delivery within a reasonable time, becomes harder to get.

At the same time the increase in engineering construction is enormous, with the expansion of business in all directions, the structures of twenty, ten or even five years ago are being torn down to give place to larger and better ones.

It is only necessary to look through the advertising pages of the technical magazines to realize to what extent engineers and contractors are now interested in this form of construction. Bridges, sky-scrapers, monster hotels, engineering structures of all kinds are being built of it.

Reinforced concrete design is at present where the design of steel structures was twenty years ago. Every would-be designer has a scheme of his own while the knowledge of principles is decidedly vague, and from the designer's point of view, it is the most rational type of construction, tensile and compressive stresses being taken by the material best adapted to receive such stresses.

Engineers and the public generally have a great deal to learn about this material. Owing to ignorance and greed, much faulty work has been done, and when some of these structures begin to fail, for they really ought to fail, there is likely to be a cry of "I told you so" from the pessimistic engineers and a wail from the confiding public.

There is no better field for the young engineer at present than to specialize on this material. It is necessary however for him to understand the principles of design. The old rule of thumb engineer and his methods, is out of date, the young engineer must understand how to place his material to the best advantage. The essentials are comparatively few and simple. It is only necessary to have them presented in the right way. A few words directing a student's mind the right way or a problem which illustrates a principle may do more to clear up a subject than a whole treatise.

It is with this in mind that the American Technical School, Cleveland, O., has prepared a course in Concrete Steel Construction. Their course in Mechanics is also quite complete.

Civil Service Examinations.

The United States Civil Service Commission announces an examination on May 23-24, 1906, to secure eligibles to fill a vacancy in the position of skilled mechanic at $1,200 per year, for service in the Weather Bureau at Mt. Weather, Va. Ask for Application Form No. 1093.

Also an examination on June 6-7, 1906, to secure eligibles to fill vacancies in the position of draftsman at $4 per diem each, in the office of the Surveyor-General, as follows: One vacancy each in Arizona, Nevada and Washington, and 4 vacancies in Idaho. Persons who pass this examination will be eligible for appointment only in offices outside of the District of Columbia. Ask for Application Form No. 1312.

Applicants should apply to the U. S. Civil Service Commission, Washington, D. C., for information and blanks, using the exact titles as given in this [illegible]ment.

e Non-Refillable Bottle.

pean countries the owner of a compelled to manufacture the hin one or two years, and to inuously.

ada the owner of a patent has o manufacture continuously but ed by law to sell at a reasona- or license his right to others at ble price.

ons in the U. S. are such that a n may buy up a patent and as soon as they please. If a takes up a mining claim he is by law to work it every year, his rights are forfeited, which the same with patented articles. inventor should feel that his brain power is a commodity, some return must be received ess he is working for the sake ity.

rs should be very careful of the y work on, for there is a vast of the money that is paid to the nt and attorneys simply wasted. stance, there has been a vast ime, money and brain power on to invent a non-refillable bottle. nt demand for a non-refillable w out of an alleged offer of a d Pepper of Kentucky, a whis- r, who, it is curently reported, failed in business.

ibt he found that bar-keepers, chasing a bottle of his stuff, erward refill with an inferior

it be known that he would give or a practical bottle, and there an immense number of cases the Patent office. The prob- difficult one to solve and no ne manufacturers would wel- levice that would prevent the bottle ever being used for anything else than the original stuff.

Inventors fail to realize the difficulties of manufacture of the bottle, that it should be of glass and that article can not be blown or molded except in certain definite shapes.

Let the waste of time, energy and money be stopped at once, or let it be devoted to some more necessary article.

Catalpa the Coming Tree.

It is expected that the marvelously quick growth of the catalpa tree and the excellence of the lumber derived from it are "destined to solve the problem of future railroad building and to furnish a supply of lumber for all purposes." Two hundred thousand catalpa trees planted near Dupuoin, Illinois, three years ago, are now thriving to such a degree that it is anticipated that in a few years this new forest, formed in the heart of the prairie, will furnish many of the ties for the Illinois Central Rail- road. Similar forests have been planted in Mississippi. Whereas oak ties last, on the average, only seven years, catalpa ties that have been in use more than thirty years show no sign of decay. The wood is also useful for building timber and for furniture making. It is said that catalpa fence posts have been known to last one hundred years. The seed planted in rich garden soil produces shoots which, when transplanted within a year, spring up rapidly into trees.—*The Young Peo- ple's Weekly.*

The Metric System.

Efforts are still being made to impress Congress with the desirability of offi- cially adopting the Metric System of weights and measures. There is no ob- jection to the Metric System so far as

its practicability and efficiency is concerned, but there is considerable objection made by manufacturers on account of the expense and inconvenience that would be entailed by the change. This need not be considered as a momentary change, for the adoption of the Metric System would be slow and future work could be made up to accord with these measurements. If in the case of a manufacturer having a large number of patterns that had been used, he could simply continue to use these for repair parts of other machines and begin to make the patterns to the Metric System and by persistent application of the equivalents the workmen in time would become accustomed to handling both styles of measurements.

It would seem that a manufacturer who has any foreign trade would realize the need of the Metric System very much more strongly than if he was dealing entirely at home. All the South American States, practically all of Europe and Asia and Africa, are using the Metric System, and to deal with these countries we must necessarily give them machines and instruments laid out with the Metric System.

The enterprising and progressive Japanese Government have shown a strong inclination to work for the trade of the South American countries and are now planning to oust United States in that trade. They are using the Metric System and will do anything to cater to the buyers of machinery in that part of the world.

The Metric System has been adopted in England, and to become universal after a certain period, thus giving them an opportunity to study the measures and become acquainted with them. This is what should be done in the United States. Every draftsman and engineer and instructor should begin to memorize and inculcate into others the advantage and simplicity of the Metric System. With the number of measures we have in this country it seems absurd to continue any longer than is absolutely necessary with such a complex system, if the engineers, draftsmen and designers become accustomed to using a centimeter as they do now an inch, a centimeter being a trifle over three-eights of an inch.

We are preparing a card for your vest pocket notebook with the Metric and conversion tables, and hope to have these ready for distribution before long. These will no doubt help the matter of the adoption of the Metric System in this country.

Don't Roll Shop Drawings.

It is a poor plan to roll shop drawings. They never lay flat when you want them.

Pasting the blue print on tin or sheet iron is much more common now than formerly and is a very permanent way to do it, too.

The paste used is white shellac and an application is made to both the paper and the sheet metal, then after laying the print on the plate squeeze out the excess juice and let dry. Then shellac the finished sheet and it will be ready for use when dry.

This method affords a thinner sheet, hence more can be placed in the rack or drawers.

To remove the sheet, hold the plate over a fire for a few moments and scrape off the paper.

A thickness of metal of 1-32-inch gauge is about right for 12 x 18 or for 18 x 24, print.

The Adjustable Axle Nut Co., London, Can., has been formed to make a ball bearing nut which will prevent wheels from "backing off."

HANDLING SAND FROM THE YAW RIVER WITH A 3-4 YARD BUCKET.

(SEE COVER.)

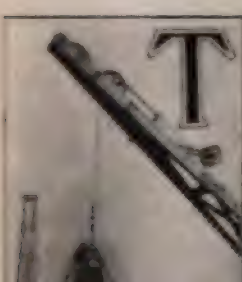
VOL. V JUNE, 1906 NO. 6

BROWNING'S INDUSTRIAL MAGAZINE

MATERIAL HANDLING BUCKETS.

THE DIGGING AND SELF-FILLING TYPE.

BY W. D. BROWNING.



THE type of material handling buckets commonly known as "grabs" or grap buckets are divided into two styles, the "orange-peel" and "clam-shell."

Foreign makers of buckets of this type designate them simply as "grabs" and arrange them to be handled by means of a single or double chain system as in this country. Most manufacturers build their buckets in three classes, according to weight: heavy, medium and light, depending on the class of work to be done.

Some make two or three styles, differing in the opening and closing arrangement.

Both styles of buckets are used for dredging, excavating, grading, placer mining and handling all kinds and sizes of coal, coke, dirt, sand, gravel, clay, broken stone and numerous other materials economically.

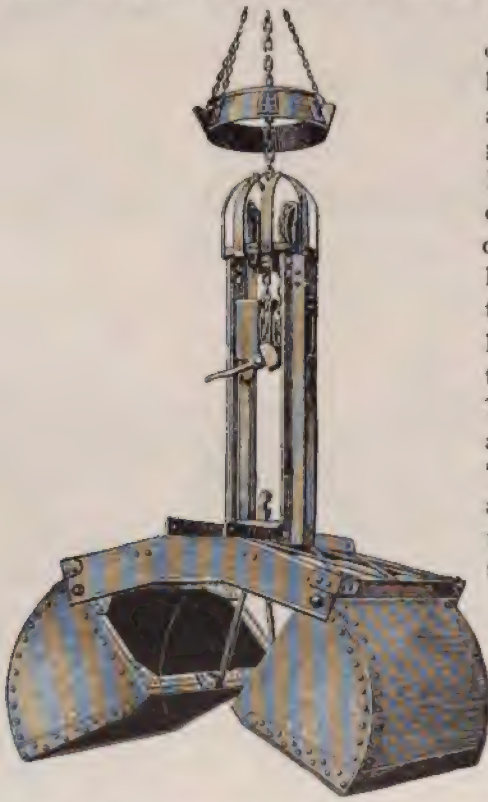
In the single rope or chain type, we have nothing automatic in the dumping device, the trip or trigger arrangement must be at a fixed point or may be controlled by a rope or chain as shown in some of the following illustrations.

THE THOS. SMITH & SONS GRAB.

This "Grab" is made by Thomas Smith & Sons, Rodley, Eng., and is of the clam-shell shape, with a single chain to the hoisting engine.

Working on the center mast is a sliding head with a trigger which engages the hook on the arms connecting the two shells.

When unloaded the shells hang apart and when placed on the material to be handled, the head with trigger is lowered to engage the hook, hence all the weight is on this in the hoisting of the grab.



As soon as the Grab lands its own weight on Coal (the cross-head being at bottom of guides and the sliding block at top of guides) the sliding block will, by its own weight, and the over-haul of the chain, run down the guides until the cross-head pin enters the hole in bottom of sliding block; this also lifts the balance weights, and the machine becomes locked. The Grab is now ready to dig, and on starting the Crane to "heave up," the sliding block and crossheads are pulled up the guides at a leverage of 4 to 1, until the Grab is completely closed. The whole is then lifted to required height, which must be also so far through the ring that the long end of releasing lever has been depressed by the ring, and having passed through it, has swung back again against the top pin. On lowering the Grab, the long end of releasing lever becomes caught against the top edge of releasing ring, thus lifting the stop plate and turning the locking pin until the two notches become opposite one another, when the crosshead being thereby released falls from the sliding block, the blades, and closing rods, also with it, the piston rod gently descending at the same time, thus preventing shock to machine, or scattering material.

The Orange Peel Bucket.

Clam Shell Bucket.

On lowering clear of the ring, the releasing lever and locking pin assume their positions again by means of their balance weights, and the machine is once more ready to be lowered into barge.

"Tines" or teeth are fitted to lower edges of the shell for excavating in light soils.

The manufacturer also makes a type of grab similar to some described later, with barrel and double rope system of hoisting.

THE AUTOMATIC GRAB BUCKET.

There are many automatic grab buckets on the market and to better describe them, it may be well to take some of the prominent ones and illustrate them under separate headings.

It may be possible to divide the automatic buckets into two classes, when considering the principle on which they operate, the

The power drum or wheel design is illustrated in Figs. 3 and by two lines of wire rope or chain, running to the hoisting drums of the engine.

The power drum or wheel design is illustrated in Fig. 3 and is applied to either the orange-peel or the clam-shell bucket.

One line of rope is attached to the top or head casting and one carried to the drum or wheel to whose shaft is connected two ropes or chains, one on each side of the drum.

By hoisting on the drum, the latter unwinds and rolls up the side chains, lifting the drum shaft and thereby closing the bucket. To dump, the drum rope is released and the head rope held, the weight of material opening the bucket.

THE ORANGE PEEL BUCKET.

The orange-peel bucket shown here may be constructed with three or more curved triangular steel plate blades and when closed forms a tight semi-spherical bowl, which contains the excavated material. The blades when open resemble sharp spades and are riveted to the horizontal arms. The inner ends are attached to a central casting; the outer ends are hinged to the vertical connecting rods, which are pivoted at their upper ends to the upper center casting. The shape of the blade is so designed as to produce the greatest digging effect with the least amount of resistance.

All bearings are bronzed-bushed and well protected against grit and dirt.

The orange-peel bucket is used in heavy excavating and the handling of broken stone and hard pan.

The Hones Grab, with chains, sheaves and sliding head. Scoops are pivoted at inside point. See page 202 for diagram.

THE CLAM SHELL BUCKET.

This style of bucket is designed especially for the handling of loose material, such as sand, gravel, coal, etc.

The sides of the blades and blade-arms are constructed of heavy steel plates and the connecting rods of solid forgings. The shoes or cutting edges are also made of steel plates turned up at each end and riveted to the sides of the blades as shown in the illustration. This re-enforcement of the blades, strengthens and adds greatly to the digging qualities of the bucket.

One of the features of this bucket is the condensed form of the head-casing, which is a great advantage over the stiff, awkward construction of the older style with its many angles and projections. The superiority of this form is thoroughly appreciated if the bucket is used in a shaft, or hatchway, but the improvement becomes very apparent by the comparison of the illustration with the plantom outlines of old style head.

The bearings of the power wheel, which is mounted upon the shaft connecting the bowls, are well protected against grit and dirt, insuring long life to the bronze bushings upon which the power wheel revolves.

Both of the above are of the drum or wheel type and constitute the principle on which a great many grab buckets in use operate.

Illustrations of orange peel and clam shell buckets Nos. 1001 and 1002 are from the North Penn Iron Works, Philadelphia, Pa.

A slight departure from the wheel or drum type is seen in the bucket built at Duisburg, Germany by the Duesburger Maschmenfabrick J. Jaeger, and which is used with their locomotive cranes.

A system of sheaves and chains do the hoisting and closing of the bucket, distributing the strain to several pins and getting greater leverage. The bucket is made up of plates and structural shapes, except for the sheaves.

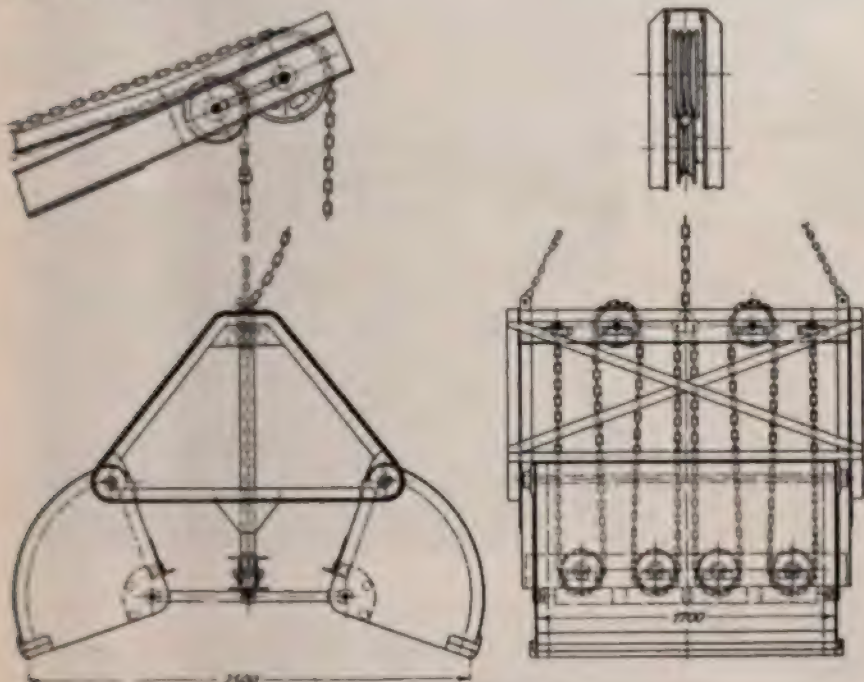
The Hone's Grab, made by the Thames Iron Works & Shipbuilding Co., England, as shown in the illustration, contains a sliding cross head with a chain and sheaves, all controlled by two chains from the engine.

This system of operating the scoops, facilitate the movement of them as shown in the diagram with greater leverage and increased opening than other makes of buckets abroad.

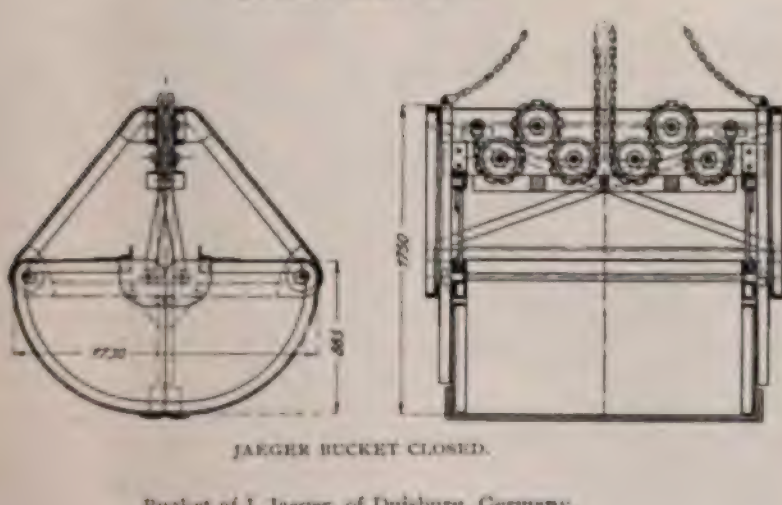
The construction of the grab is clearly shown so that a description is hardly necessary and the diagram is self-explanatory.

These "grabs" have a 6 to 1 purchase block for applying them to existing double chain cranes.

This firm also builds the bucket shown on page 196, and the diagram on page 202 shows the advantage of hinging the scoops at the outer corners.



JAEGER BUCKET OPEN.



JAEGER BUCKET CLOSED.

Bucket of J. Jaeger, of Duisburg, Germany.

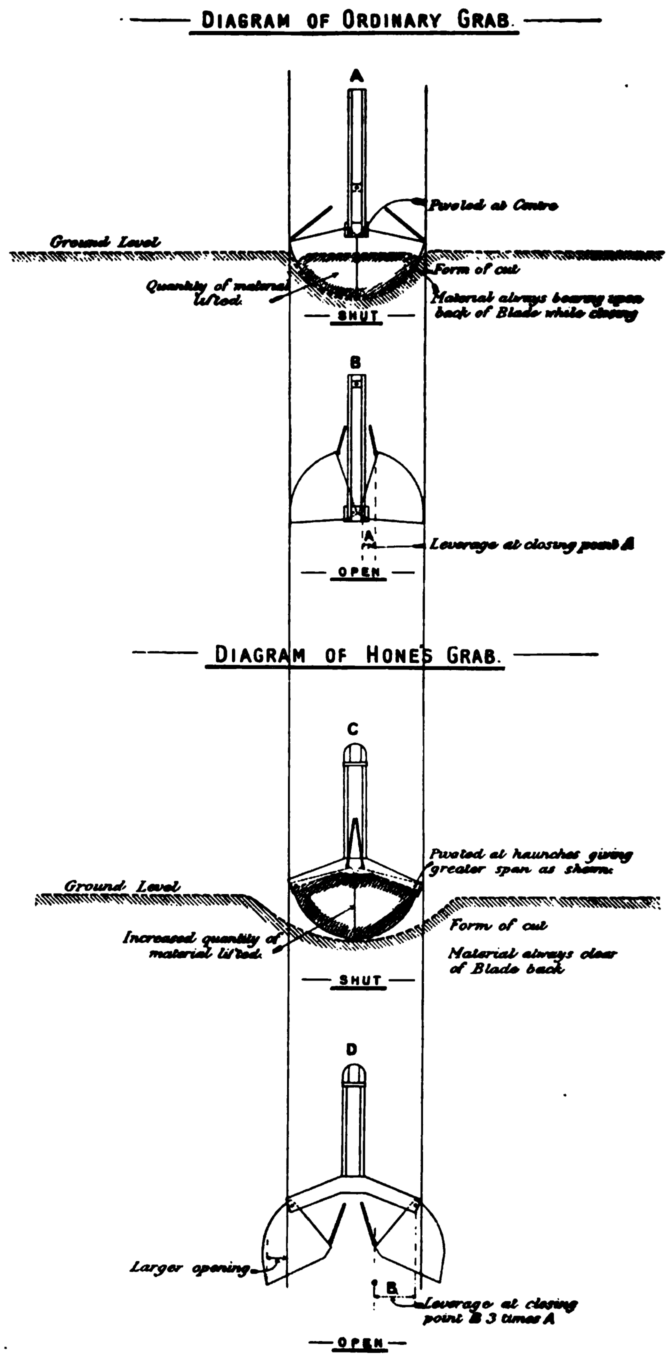


DIAGRAM OF ORDINARY GRAB.
A
Pivoted at Centre
Ground Level
Form of cut
Quantity of material lifted.
Material always bearing upon back of Blade while closing
SHUT
B
A
Leverage at closing point A
OPEN
DIAGRAM OF HONE'S GRAB.
C
Pivoted at haunches giving greater span as shown.
Ground Level
Form of cut
Increased quantity of material lifted.
Material always clear of Blade back
SHUT
D
Larger opening
B
Leverage at closing point B 3 times A
OPEN

The Carl Flohr Co., Berlin, Germany, build the bucket shown here of plates and structural shapes.

The sliding head, as seen in other foreign makes, is condensed into a sheave frame connecting with links to the scoops.

The scoops are hinged at the upper corners, affording a wider range of action on the material to be handled. There are two ropes to the engine, one headed onto the top pin, and the other runs back and forth over the sheaves for opening and closing the scoops.

THE SWEDENBORG GRAB BUCKET.

The power is applied to this bucket through a large size cast steel power wheel mounted on shaft about the center of the upper frame. Keyed to this same shaft are two small cast steel pinions. On the back of this frame are two other shafts which carry cast steel geared segments, the lower ends of which are attached to the scoops. These segments are arranged in pairs and geared together, being provided with male and female teeth so that ore or other material cannot lodge in the same. These segments mesh with the pinions on power shaft above mentioned. The backs of the scoops are carried by steel links to pins on the opposite segments.

The opening of the bucket is attained by chain or cable on a small cast iron hub also mounted on power wheel shaft. The opening motion is just the reverse of the closing.

The whole mechanism is very powerful and at the same time simple, and together with the peculiar closing motion makes it very efficient at digging.

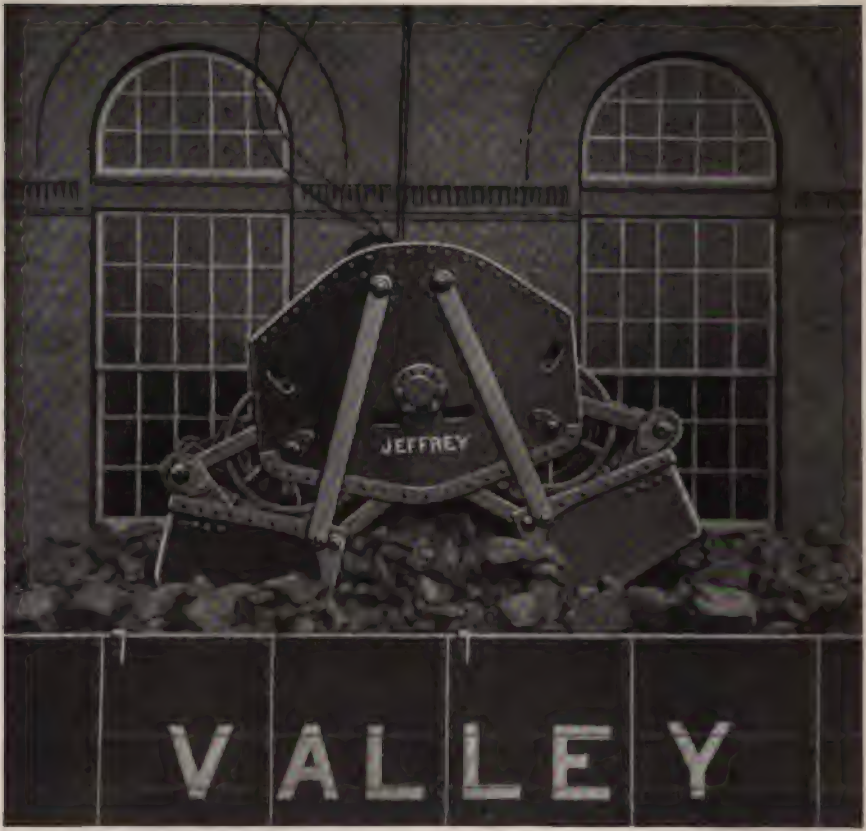
The buckets are built for either ore or coal in any sizes from one ton up, by the Macbeth Iron Co., Cleveland, Ohio.

THE HULETT PATENT EXCAVATING BUCKET.

The Hulett Bucket consists of a frame to which are attached the scoops and operating mechanism, the power for closing the scoops being derived from a power wheel and cam motion, which is connected to the blades by flat link chains. The general arrangement is such that in operation the resistance is reduced to a minimum, and yet the bucket is enabled to pick up an increased load, the movements being so designed that the weight of material cut out by the blades assists in holding the bucket in the material, so that there is no tendency for the bucket in closing to lift away and fail to pick up its load; in fact, it requires less power to close the bucket than to lift it with its load. The ratio between the power wheel and the cams is such that the force obtained on the cutting edges is from four to six times the dead weight of the bucket. The bucket when in an open position rests on a very broad area, hence the tendency to tip is practically done away with. In this position all the power mechanism is clear of the bucket space, and the entire weight of the bucket rests upon the scoops or blades, obtaining the full effect of its weight in forcing the cutting edges into the pile. The head room or height of frame is much less than in the ordinary type of bucket. The buckets are made in two weights, the heavier weight being designed for handling

Hulett Bucket Open

Hulett Bucket Closed



The Jeffrey Bucket.

heavier and more obstinate materials, such as lump iron ore, limestone, etc. The lighter style is for coal, sand and like material. The buckets are built in sizes ranging from 21 to 181 cubic feet capacity, by the Wellman-Seaver-Morgan Co., Cleveland, Ohio.

THE JEFFREY BUCKETS.

The Jeffery Mfg. Co., Columbus, Ohio, make two designs of buckets, one on the order of the wheel or drum style, and the other on the scissor principle.

In the first design a system of levers and wheels operate the scoops in a very powerful manner. The mechanism is housed in a casing covering the shafts and levers.

The bucket is arranged to open quite wide and when closed occupies only about two-thirds of the extended position.

The capacities listed are from 21 to 160 cu. ft. and the buckets built to work in ore, coal, broken lime-stone, sand, gravel, and any like material.

THE BROWNING BUCKET.

This make of bucket presents no departure from the plain wheel or drum style, but experience has taught the builders the weak points and these have been eradicated.

Browning Bucket Digging Sand.

The first ones built were of the square or box shape with a later form with a sloping bottom, as seen in the illustration.

For handling sand or granulated slag, the shell is perforated to permit the water to run out.

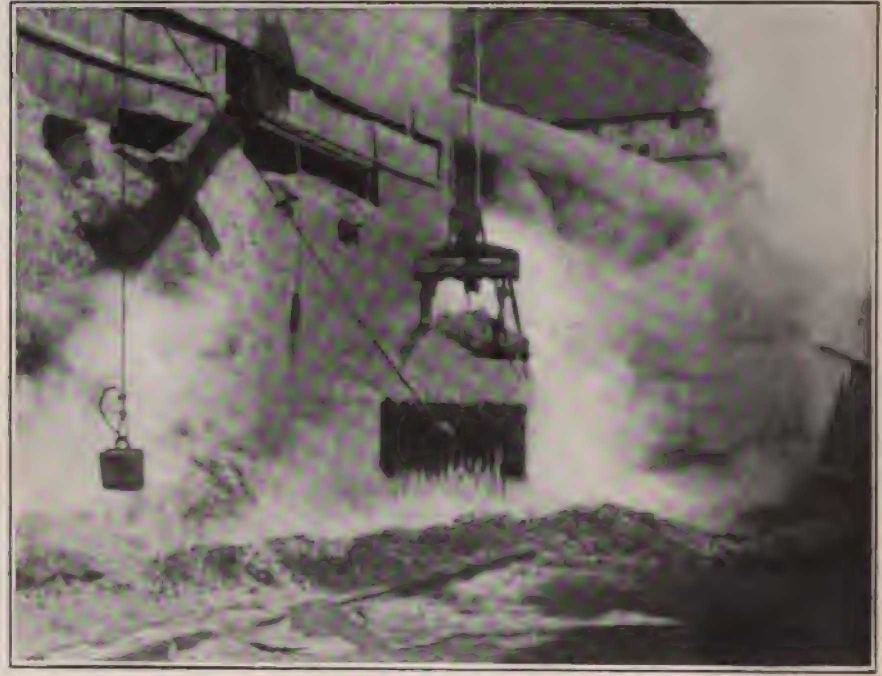
An illustration is here given to show the hard usage of this make of bucket, in the slag pit of a blast furnace.

The guide rope and weight shown in the foreground are to prevent the bucket turning, thereby twisting the hoisting ropes.

The buckets present the best practice in workmanship and material.

THE KIESLER BUCKET.

The automatic bucket of the four prong and clam shell types, built by the Kiesler Co., 68 Pratt St., Chicago, Ill., have a system of leverage that is a distinct departure from any other means of operating an automatic bucket. These levers reach down into the body of the bucket, and the power is applied where it develops the most efficiency, and not at the top of the bucket as nearly all other four prong and clam shell buckets are made. Another important feature is that



Showing hard usage of a Browning Bucket in a slag pit of a blast furnace.

two of the prongs are made with a flat lip 15 inches wide and these prongs being about 12 inches lower (when the bucket is open) than the two sharp prongs, prevent any injury to either boats, cars or in whatever the bucket may be working. In buckets to be used for excavating or dredging these lips are made narrower. These buckets can be operated on any hoisting tower, crane, bridge, tramway, dredge or derrick using a two line hoist without any change to the machinery, and on a one line hoist by the addition of an idler drum and counter weight which is very inexpensive. Placed (not dropped) in any

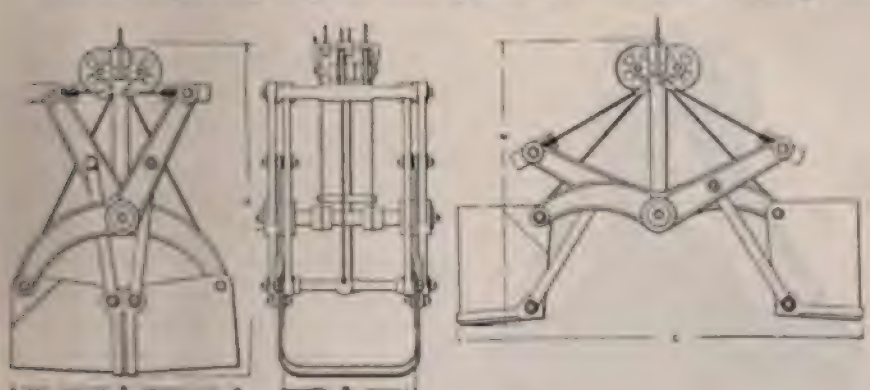
position on a pile of coal, iron ore or other material, in the act of closing, it penetrates into the material and fills. This is caused by the action of the levers and the shape of the shell, causing it to settle down in the material instead of having a tendency to pull out as is the case in all other chain operated buckets. The action is to dig down instead of scraping along the pile, which eliminates the breakage of large lumps when working in soft coal. For working in boats, it cleans out between hatchways better than others, as it does not have to be dropped and consequently can be swung to either side under the deck and falling in any position will fill.

In actual working conditions, a two-ton bucket in unloading 40-ton cars of Hocking coal, about 85 per cent was unloaded in 30 to 35 minutes on an average. For use in loose material such as hard coal, crushed stone, sand, gravel, etc., the clam shell bucket has the same superior qualities over other clam shells that the four prong has, it having the same system of leverage, which gives it great closing powers.

It is very simple in construction and has few parts to get out of order.

BUCKETS OF THE SCISSOR DESIGN.

In the following is given descriptions of the "scissor" design of



Jeffrey Bucket Scissor Design.

bucket, which as seen, applies only to the clam-shell style, the shape of the spoons being determined by the nature of the material to be handled.

The scissor design, as shown in the illustration, made by Jeffery Mfg. Co., represents a departure in principle from most of the buckets on the market.

The diagram shows wide spread, flat path and the makers claim great closing power.

The system of levers and sheaves operated by two lines to the engine drums work the scoops. The diagram is no doubt descriptive enough for all general purposes.

THE "FAIVRETTE" CLAM SHELL BUCKET.

Clam shell buckets are, and have been the subject of much thought, and experiment during the past sixty years, in 1846 the first United States patent on a bucket of this description was issued. Since then hundreds of patents have been granted, and each year adds to the number. In many cases the designs are complicated and of questionable value, but the bucket illustrated herewith is noteworthy because of its simplicity, and apparent digging force.

It will be seen that the two scoops members are hinged together in the ordinary way, but that the hinge end of one of the scoops extends beyond the hinge, forming an arm at the outer end of which is a sheave. At a point near the outer end of this arm is dead-ended a cable which passes around one of the sheaves located in the "head" of the frame supporting the scoops. The cable passes back around the sheave at the end of the arm, up to and under the second sheave in the "head." This cable, thus multiplied, forms the closing power of the bucket.

To the "head" is attached a second cable which is used to lower the bucket and to hold it in position while opening.

This is the manner of constructing and operating, when single closing and opening lines can be used, when it is desirable to operate the bucket from a conveying bridge, a double arm is provided with a sheave in each, and two sets of sheaves properly located are placed in the "head" to correspond with the sheaves in the arms, and two closing cables are used, while an extra sheave is located on the center ot the pın which connects the different parts of the "head" together, around this extra sheave the opening line passes, thus forming two parts of the opening line.

These buckets are designed for all classes of work, as the scoops are formed to produce the best results when used in the different ma-

terials in which they are to operate, for instance, in iron ore an open end scoop is considered the best, while for coal, and other loose materials different forms of scoops with closed ends are used.

THE "FAIVRETTE" CLAM SHELL BUCKET NO. 2.

The first bucket of this particular type built was one of 3 yards capacity on the lighter "Rescue," owned by the Great Lakes Towing Co., of Cleveland, Ohio. This bucket has been subjected to severe use under adverse circumstances and has given satisfaction, since then many others have been built, all of which have proven equally satisfactory, and are to be found working in iron ore, coal, sand and gravel, while several are used for excavating purposes.

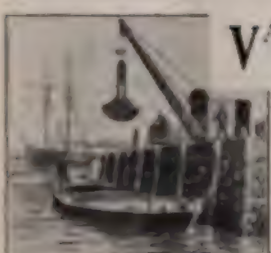
The bucket is the invention of Mr. Williams of the G. H. Williams Co., 1512 Rockefeller Bldg., Cleveland, Ohio, by whom the bucket is manufactured.

It has been found necessary to omit the description of some well known makes of buckets, because the matter could not be obtained in due time. In some cases, the makers hesitated in allowing material to be printed, but there was no intention to slight anyone, as this review is unbiased in every particular.

Fig. 2—Three Ton Electrically Operated Crane at Glasgow, Scotland.

RECENT ELECTRIC HARBOR CRANES IN GREAT BRITAIN.

BY FRANK C. PERKINS.



VARIOUS types of harbor cranes are employed in Great Britain, of German as well as of English design and construction, and electric power is being utilized more and more for this class of service.

The accompanying illustration, Fig. 1, shows a new 100-ton hammer crane recently installed at Dublin, Ireland, by the Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nuernburg, A. G., while Fig. 2 shows a three ton electrically operated crane in operation at Glasgow, Scotland, as installed by Stothert & Pitt, Ltd., of Bath, England.

This portal type of jib electric crane was constructed for the Clyde Trustees and represents a form of crane largely used in English harbor service. Half portal cranes are also largely employed of the general type of those shown in illustration, Fig. 4, the drawing, Fig. 3, showing the construction of the electric hoisting apparatus of one of these Englis five-ton electric cranes at Heysham harbor.

The German 100-ton hammer crane first mentioned, it will be noted in Fig. 1, is mounted on a low tower with six standards, which are provided with very heavy trucks, so that the entire crane may be moved along on the foundation provided for the purpose. Two cabins are provided, one being located on the top of the main girders and the other within the framework. The trolley carrying the heavy loads up to 100,000 kg. may be operated the whole length of the superstructure, which may be rotated through an entire circle if desired.

The Midland Railway Co. have recently installed at their new harbor works in England a modern equipment of electric cranes and capstans. The five-ton electric cranes at Heysham harbor, installed by Stothert & Pitt, Ltd., of Bath, England, are equipped with motors

and switches of the type built by the British Westinghouse Co., the arrangement of motors and hoisting gear being shown in the accompanying drawing, Fig. 3, while the six half-portal wharf cranes are shown ready for operation in the accompanying illustration, Fig. 4. These cranes are designed to lift five tons at a 34-foot radius and are worked by traction motors of the series type, the lifting motor having a capacity of 40 h. p. and the slewing motor an output of 7 h. p., the speeds for lifting and slewing being respectively 100 feet

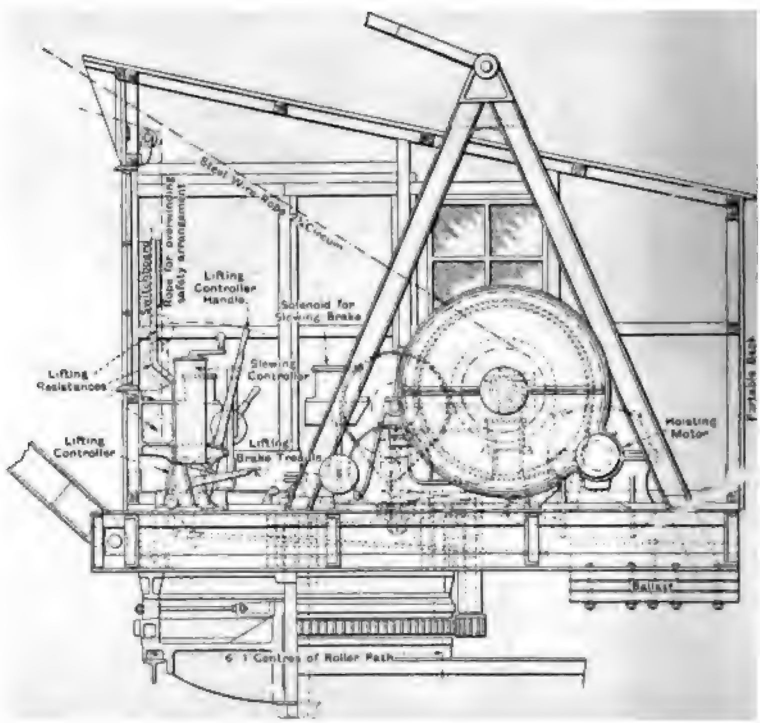


Fig. 3—Electric Five Ton Crane at Heysham Harbor, Lancashire, England.

per minute and 400 feet per minute at the hook. By unshipping the snatch-block for double purchase and unslinging the hook at the end of the rope from its eye at the jib head and so using it in single purchase for lifting, half the weight can be lifted at double the speed of lift for full load. For the slewing motion double reduction gear is used and for conducting the current to the cranes about every 40 feet plug fittings have been provided and a twin flexible armored cable is utilized. The lifting drum is not keyed directly to the shaft, but is connected and disconnected by means of a coil friction clutch running loose upon the shaft when the friction clutch is disconnected. The

Fig. 4—Five-Ton Cranes at Heysham Harbor.

Fig. 3—New German 100-Ton Hammer Crane recently installed at Dublin, Ireland.

Fig. 5—A 100-Ton Rotary Tower Crane at Dublin, Ireland.

lifting motor, therefore, is never reversed and always operates in one direction by this arrangement. The winding drum shaft has keyed to it a main spur wheel, which gears directly with the pinion by single reduction with the lifting motor armature shaft. An electric solenoid is operated by a lever on the lifting controller which controls the lifting friction coil clutch. By moving the lifting handle from the off position forward it is so designed that the current is allowed to pass through the solenoid and the clutch is placed into gear and electric lifting motor being started at the same time. As soon as the clutch is in gear resistance is cut out by further movement of the lever and the motor attains full speed. A mechanical brake is applied by means of a treadle and only two working handles are utilzed, one for operating the slewing mechanism and the other for controlling the lifting motion. At the Heysham Harbor, the Midland Rwy. Co. also has installed a smaller wharf crane designed to life 2,000 lbs. at a speed of 250 feet per minute with a slewing speed of 40 feet per minute at the hook. This crane is equipped with a four h. p. motor and a 40 h. p. motor. There are also six 1.5 ton jib cranes of the two motor type, each of which is equipped with a 3 h. p. motor for slewing and a 12 h. p.

motor for lifting, the speeds being 250 feet per minute at the hook and 80 feet per minute respectively. These cranes are of similar design to the larger cranes, the electrical mechanism being provided with no-voltage release so that the lifting drum is held in case the electric current supply should fail for an instant, the controller being thrown back, an over-travel device also being provided. At the end of the jib there is a curved lever which is so arranged that when the hook rises against it a trigger is released by means of a cord and a weight is caused to fall under the influence of a dashpot, thereby stopping the lifting motor and putting on the brake automatically, the load being held in that positon. Until the brake is free it is interlocked with the controller so that the motor can receive no current.

By means of the "free barrel" design or loose drum with friction clutch arrangement there is a great increase in the speed of lifting and lowering and there is less danger of a failure on the part of the motor, as it is not necesary that the armature should be instantly stopped and reversed, the motor being of the non-reversible type. With reversible motors it is also necesary to take into consideration the momentum of the revolving armature when the hook nears the jib-head, otherwise the lifting motor will not be checked soon enough, but with the free winding drum arrangement and friction clutch the lifting speed can be continued at a maximum and the load brought to rest instantly by operating the lever, the brake drum and the barrel only being required to stop, these parts having a small inertia. By this arrangement the curve of current for the motor is practically horizontal line and an excessive current is not required at starting.

CONCRETE MIXING MACHINES.*

BY CLARENCE COLEMAN, M. AM. SOC. C. E.

The use of concrete is now so general and is extending so rapidly in various fields of construction that increased efficiency in its manufacture has become a matter worthy of some attention. The objections to machine-mixed concrete have almost disappeared, it being recognized that this material possesses equal advantages with hand-mixed concrete, while for construction work requiring large quantities of concrete, the use of mixing machines is almost indispensable. A great variety of concrete-mixing machines are now in use, and the writer has recently made a study of their comparative efficiency. The purpose of the investigation was to deal simply with the economics of the process of mixing concrete by machine. Assuming the use of good cement, stone, sand and water, it was desired to determine the machine which would most economically and effectively mix these materials and produce a concrete of desired consistency, whether wet or dry.

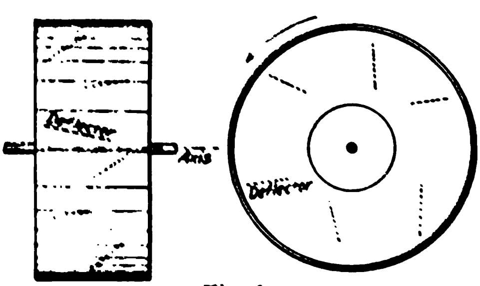


Fig. 1.

CLASSIFICATION OF MACHINES.

Concrete-mixing machines are of two general types: First, batch mixers; Second, continuous mixers.

Batch Mixers.—In this type may be included the following:

(1) A revolving drum or cylinder (with horizontal axis), fitted inside with deflectors, and capable of receiving and discharging a batch without stopping. The concrete is visible during the operation of mixing. Fig. 1.

(2) A revolving drum formed by two cones (with horizontal axis), Fig. 2. This also has inside deflectors, can receive and discharge a batch without stopping, and the concrete is visible during mixing.

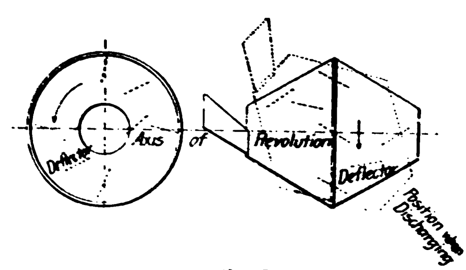


Fig. 2.

(3) A revolving circular pan or trough (with vertical axis), Fig. 3. The materials are deposited in the pan, and leveled by means of a fixed spreader. A frame with radial arms carrying a series of plows is lowered into the pan and mixes the materials as the pan revolves. This receives and discharges the batch without stopping, and the concrete is visible during the process of mixing.

(4) A horizontal revolving cylinder which stops to receive and discharge, and mixes the concrete by revolving about its

* Reprint of an article in Engineering News which was put in pamphlet form by the ... and Contracting Co., Railway Exchange, Chicago, Ill.

This has been adapted to form a ieeled wagon, Fig. 4, the cylinder evolved by gearing from the axle. ; the batch of concrete may be during transportation. The con- concealed during mixing.

A horizontal trough of semi- ical cross section, Fig. 5, with a dinal shaft carrying blades. These are set at an angle so as not only the material, but also feed the toward the discharge end. The ls are thrown in and concrete dis- l without stopping the machine. concrete is visible during mixing.

A cubical box revolving about a tal axis passing through two di- y opposite corners of the box. The materials are introduced 1 a d or in one side, and the con- s discharged through the same The machine stops to receive and he batch, and the concrete is not during the mixing.

A cubical box revolving about a tal axis as in Fig. 7; see cut; but the corners through which this sses cut away to form openings eiving and dumping the batch. x can be tilted to discharge its d need not therefore be stopped se operations. The concrete is during mixing.

nuous Mixers.—Under this class ncluded the following:

An inclined chute fitted with g. 8. The materials are thrown ie upper end, and slide down by being mixed by the continual de- s caused by the pins. The con- visible during the process.

A series of funnels placed one he other, and having in the wide of each funnel an inverted cone ; a baffler, Fig. 9. The upper s closed by a slide, and forms the for the cement, sand and stone, which are deposited in the order named and followed by the necessary quantity of water. The slide is then withdrawn and the materials fall by gravity, being mixed during their descent. The concrete is for the most part invisible during the process.

(10) A long inclined box, square in section, revolving on its axis, as in Fig. 10. The materials are thrown in at the upper end, and the concrete is discharged at the lower end, being practically invisible during the process.

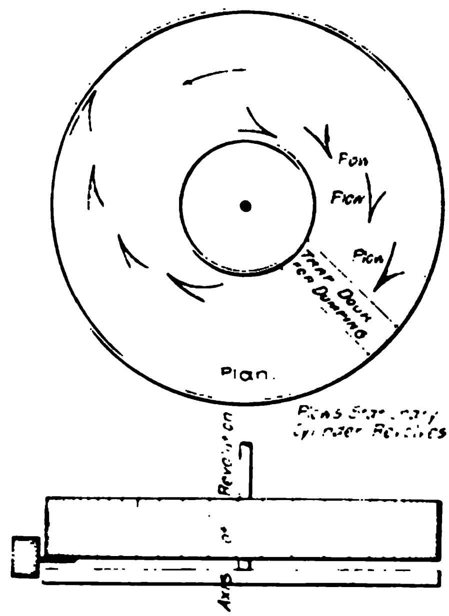


Fig. 8.—Pan Concrete Mixer.

(11) This is somewhat similar to No. 10, but the box is of cylindrical form and is fitted with deflectors, as shown in Fig. 11.

(12) An open trough or closed cylinder fitted with a shaft on which are paddles or blades, to mix the concrete and feed it along to the discharge end, as shown in Fig. 12.

COMPARISON OF CONCRETE MIXERS.

Proceeding to consider the two general types of concrete mixing machines, it will first be necessary to inquire whe'

er all of the machines above enumerated actually fulfill the requirements for a batch mixer. The fact that a machine receives at one time the materials composing a batch of concrete does not establish it as a batch mixer. To deserve this title there should be a very reasonable certainty that the entire mass has commingled in the process of mixing; that is to say, that the mixing has not been performed along certain lines or planes. It may readily be seen that with a very perfect distribution of the aggregates, fairly good mixing could be performed without bringing all parts of the mass again and again together; but this nice distribution of materials does not obtain in the ordinary operations of concrete mixing, and therefore the machine must be depended upon to so constantly change the position of the particles as to insure the most perfect commingling of the mass, and through that condition accomplish as nearly as possible the uniform distribution of the cement throughout the batch.

With a machine of Class 1, whether the cement is dumped suddenly or poured on the aggregates, there is a decided tendency to produce concrete much richer in cement along the vertical section (at right angles to the axis of revolution) upon which the cement falls, and the distribution of cement along lines parallel to the axis of revolution in this section will vary in proportion to the thickness or volume of cement which is superimposed. That is to say, the pile of cement being dumped or poured with its greatest depth on a line at right angles to the axis of revolution and equally distant from the two end planes of the revolving drum or cylinder, will mix quickly with the stone and sand immediately underlying it, and will be carried very slowly and thinly towards the end of the drum, with result that the mass of concrete composing the central section as described, will be much richer in cement than the portions of the mass next to the ends of the drum. To insure an equal distribution of the cement in such machines, it has been recommended that the water be put in first, then the cement, and afterwards the other aggregates. In this case the water is made to act as a vehicle for the distribution of the cement. This treatment of cement is, to say the least, of doubtful practice.

The same objections, though in a lesser degree, apply to Class 2. There is no evidence that the mass of concrete being mixed is moved to any great extent in lateral directions between the vertices of the rotating cones. With Class 3, the cement is spread mechanically and quite

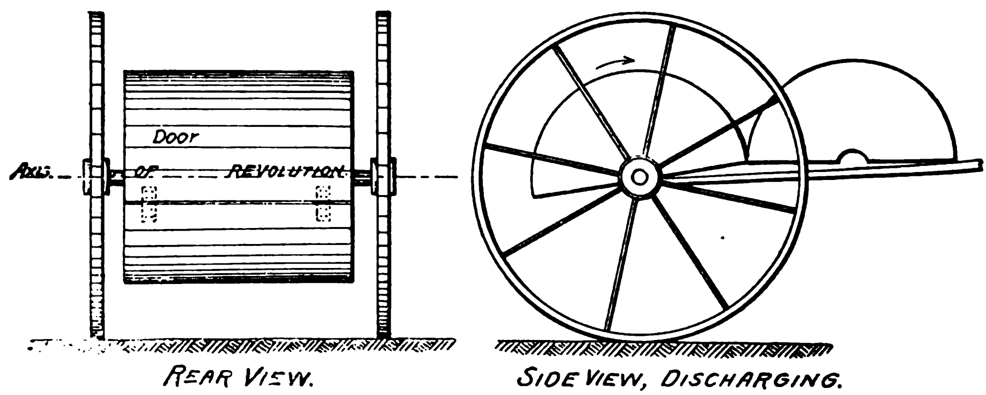


Fig. 4.

over the surface of the other ag-
es which have been previously
. The mass is mixed by the rota-
f the pan or trough carrying the
ates against the fixed plows, which
set as to turn it alternately to the
and left, and are also staggered
to gradually move the mass from
le of the pan to the other. The
of the machine depends upon the
ly even distribution of the cement
e surface of the other aggregates
the mixing is commenced. (Fig.

s 4 has the same restrictions with
ce to the lateral movements of
rticles as Classes 2 and 3, but in
e marked degree, as it depends
upon the rotation of a cylinder
a central axis. (Fig. 4).

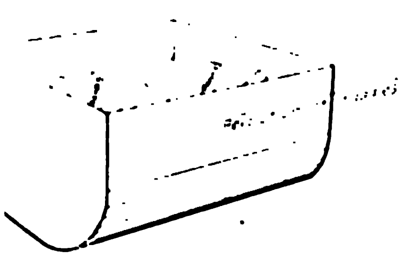


Fig. 5 Trough Concrete Mixer.

lass 5 the mass of aggregates is
distributed by the rotation of pad-
arms fixed in a revolving shaft.
re is no evidence that the particles
sing a batch of concrete are caused
and repass each other in a di-
parallel to the axis of revolu-
ig. 5).

lass 6 (Fig. 6), the planes which
te the sides of the cubical box
ing its revolution in a very posi-
nner on the aggregates.

of the six planes acting alter-
in one revolution of the cube,
to throw the concrete from a plane
ng a curve of ascension against
e with curve of descension; this
of position with regard to the
contents of the cube occurs with each one-sixth revolution of the cube about its axis, and thus the concrete is thrown from one side to another of the cube six times during one revolution

At the same time that those lateral movements of the mass of concrete are being alternately produced by the angles of the planes or sides of the cube to the plane of axial revolution, the whole mass of concrete is being lifted along the plane of axial revolution until the angle of repose for the material is passed, when it gravitates back along lines of direction which intersect the paths of these particles projected by the alternating positions of the sides of the cube in its revolution.

Fig. 13 shows the appearance of a cube being rapidly revolved about a diagonal axis. It will be seen that the optical illusion of a curve is produced between these corners which rotate in two vertical planes, by the infinity of change in the positions of the sides or planes of a cube revolving on a diagonal axis. Assum-

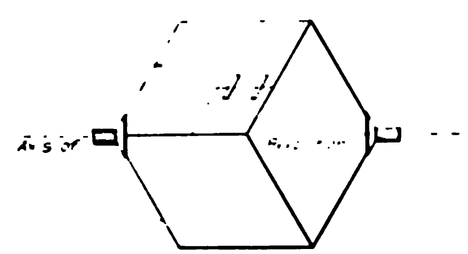


Fig. 6 Cubical Box Concrete Mixer with di...

ing a level plane of vision passing through the axis of revolution of a cube, the focus of a plane being equi-distant from the ends of the axis, the six upper diagrams would show consecutive views of a cubical box mixer suspended at its diagonal corners, on a horizontal axis, each diagram showing the two visible sides of the cube for one-sixth of a revolution. The arrows indicate the direction in which the concrete would be moved by the action of each plane or

side of the box in the course of one revolution.

Fig. 7 represents a cubical mixer embodying all of the advantages shown for

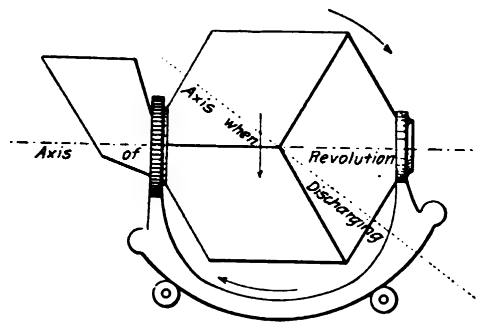


Fig. 7.

Class 6, and eliminating some very decided disadvantages of that class. In this mixer the concrete is visible during the entire time it is being mixed, and the machine receives and discharges the batch without stopping.

In the continuous machines, as shown in Figs. 8 to 12, the aggregates pass

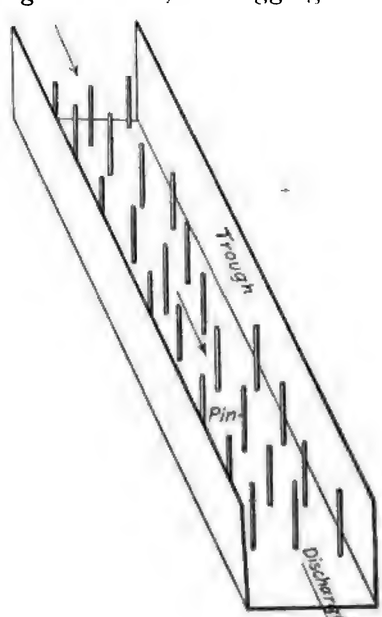


Fig. 8—Gravity Concrete Mixer with Pins.

through in a continuous stream without being brought together and mixed as a mass by the machine. This greatly complicates the question of uniformity with the resulting concrete, both as reg; the even distribution of the cement the proper administration of water. would be useless to compare contin mixers with batch mixers, as the for fail in respects which the writer a cates as essential in the economic duction of good concrete.

Table III. embodies some of the clusions which this review of metl and machines for mixing concrete evolved, with reference for types

Batch 1.....	25	25	5	5	5	7
" 2.....	30	25	8	5	5	9
" 3.....	30	25	8	4	5	9
" 4.....	20	5	2	3	4	6
" 5.....	20	25	6	5	4	6
" 6.....	40	5	10	3	3	10
" 7.....	40	25	10	5	5	10
Cont. 8.....	10	5	2	2	3	5
" 9.....	10	3	1	1	4	5
" 10.....	15	12	2	4	4	6
" 11.....	15	12	2	4	4	6
" 12.....	15	25	6	4	4	6

classes under discussion and their fa ties for performing certain funct which are considered important in manufacture of concrete. The value signed to these functions though a trary are belived to be in accord with the relative degre of importanc the functions for which they are gi

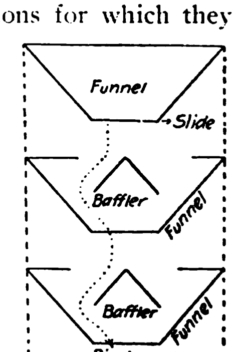
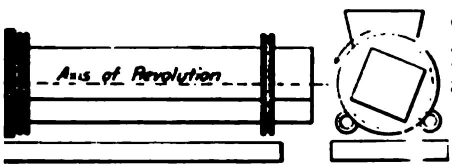


Fig. 9—Gravity Concrete Mixer with Fu

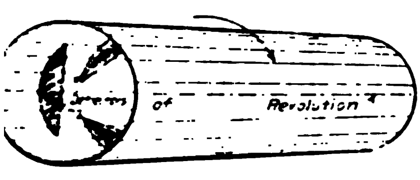
These values could hardly be other arbitrary, as perhaps
would hold the
to the v

ions. The credits given to contin- mixers in column A are intended to the relative values of the contin- mixers considered from the func-



. 10—Elongated Box Concrete Mixer.

of mixing only; and to compare values with the perfect value for ch mixer. In other words it is a *arison* of the result of the mixing rmed by the continuous machines



g 11—A Cylindrical Concrete Mixer.

the *higher values assigned to batch g machines on the same work.*

e various classes of machines have considered merely from the point eir ability to perform positively the ons for producing the most perfectly mixed concrete. No comparisons are attempted as to cost of operation, as it can be readily understood that machines of low efficiency and minimum cost of operating can in no way be compared with machines with high efficiency, and higher cost of operating; the great desideratum being always the perfect

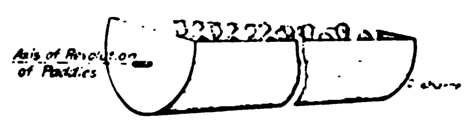


Fig. 12—Trough Concrete Mixer.

product. I am very much of the opinion that some machines produce good concrete and others produce bad concrete. If a poor machine is made to produce good concrete through taking sufficient care in the manipulation, then the credit is not properly with the machine, but is due to the manipulation. For instance, a shovel is one of the most perfect mixing machines I have ever had experience with, but the manipulation required is intense. *The best machine for practical work is that which will produce good concrete in large quantities with the least time and manipulation.*

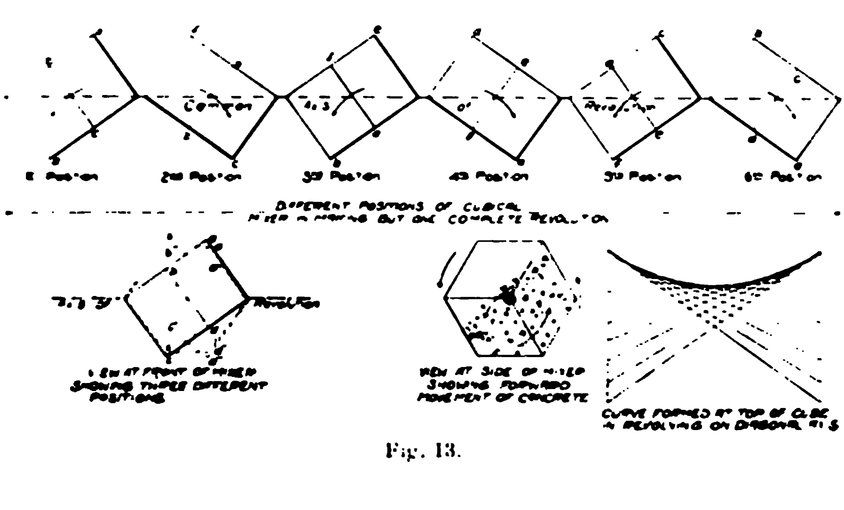


Fig. 13.

A SCRAPER EXCAVATOR.

Although comparatively a new machine, there has been enough done with it to prove that it is no experiment, though tried on different classes of materials.

The illustrations show a derrick mounted on a framework built to swing and thereby permit the scraper or bucket to dump its load in a new place each time.

The entire upper half of the machine, including the boom, engines, etc., rest upon from 18-inch diameter, extra heavy, single flanged, chilled car wheels which revolve on a 20 ft. diameter 60 lb. steel T-rail circle.

A heavy center casting is also used for centering the wheels on the rail.

The frame work carrying the track rest on two 12"x14"x28 ft. timbers, forming the skids which are 26 ft. center to center.

To these last skids are bolted four 4"x 12"x12 ft. hard maple shoes or runners.

The body of the machine is moved on 7-inch diameter hard maple rollers running on planks as a roadway.

To hold the machine while digging, the front and rear rollers on each side are simply blocked by a piece of 4x4, concaved slightly.

The A-Frame is made up of 12x12 timbers and is 26 ft. high, extending to the center of the machine and strengthened by two 1¾ suspension rods run through a 10x12 oak timber at the rear of the frame base.

Scraper being swung to dumping place.

o secure stiffness, the boom is made wo timbers spread about 40 inches at base, reinforced by several spreaders bolts. The boom rests on a 3-inch t passing through main timbers sup-ing the engines.

or booms up to 50 ft. in length, two 5-inch timbers are used and for a hine with 26 ft. A-frame, a 75-ft n is seldom recommended.

he booms are set and seldom moved r beginning the work, and 10 ft. is distance from base of boom to center machine.

he scraping bucket is lowered di-ly under the boom point and is pulled rd the machine by the drag line. It lled in one to two times its length nding on the class of material ed and when filled is hoisted, the g beginning at the same time of the ing of the bucket.

he point of the bucket is held up by nsion rope and when ready to dump the engineer simply slacks up on the drag line.

In ordinary digging, an engineer ought to average one load in 45 seconds and machines have dug four buckets to the minute for 45 minutes straight; one bucket per minute for ten hours is a better calculation and perhaps nearer the actual operation of the machine. For a two yard bucket, this would mean 1200 cu. yds. for 10 hours.

The machine can be used to handle a clamshell or orange-peel bucket for deep digging.

Scraper dumping.

These machines are the product of the H. Channon Co., Chicago, Ill.

Some New Inventions.

Specially reported for this magazine by C. Leroy Parker, Solicitor of Patents, 639 F Street N.W., Washington, D. C., to whom all correspondence with reference to this matter should be addressed.

CONVEYING DEVICE.

No. 814,933. March 13, 1906.

I. E. Bendickson.

This invention relates to a novel conveying device and has for its principal objects the provision of a simple and strong construction of frame for supporting a carrier mounted in such a manner as to be easily dumped and formed in such a way as to readily discharge all material therefrom when moved to dumping position. Another object of the invention is to provide means for controlling the dumping of the carrier and for keeping the frame on the trolley track.

As shown the invention embodies a frame having a head, a bracket connected with the head, a shaft rotatably mounted on the bracket a plate fixed to the shaft and having a depression for receiving the lower part of a trolley rail, the plate constituting a guard for the trolley rail, and a trolley wheel mounted on the bracket above the guard, the plate having a flat lower surface adapted to engage the head to prevent the rotation of the plate and shaft when the head is lifted into engagement with the flat surface.

Fig. 1

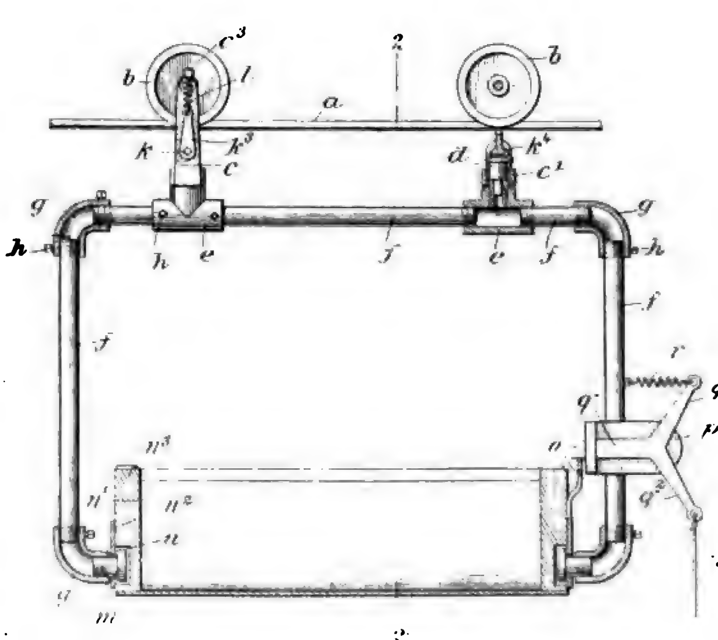
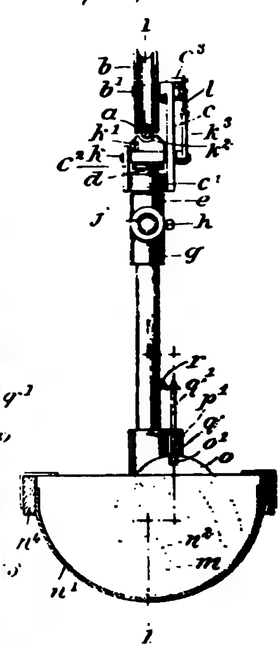
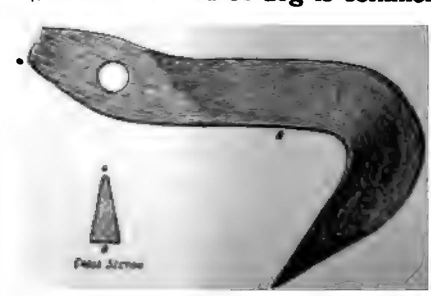


Fig. 2



Forging a Lumber Dog.

The lumber dog shown in the sketch is made of steel $\frac{7}{8}$x2x13 in., punched at one end and drawn out as if for sharpening a chisel. It is then bent about two-thirds of the way round and the back drawn down as thin as possible, but still leaving the point full width of the steel, or $\frac{7}{8}$ in. This kind of dog is commonly



used in Oregon, says a correspondent of the *Blacksmith and*

ENGINEERING DEPARTMENT

INCLUDING

DRAFTING ROOM PRACTICE.

ng, Mounting, Filing and Checking Out of Blue Prints.

BY ERNEST J. LEES.

g Blue Prints:

a modern manufacturing shop drawings are made of the product lueprints are used to work from, ed of rapid blue printing has led use of the rapid paper and the c blue print frame. A handy electue print frame that has been in r several years is shown by 1 is the assembly, by referring to d to the details, it will be noticed that the frame is of the type that uses the fixed hanging arc lights and steel reflectors built in the lines of a parabola.

The main frame swings down from a hinge at the back and the glass is held in a steel frame, also hinged at the back and supported by two wires at the front with a coil spring attached to reduce shock in opening and closing.

The pressure on the cloth and paper is obtained by the weight of the glass on top and the main frame from below actuated by a counterweight on each side which controls a cam lever and in its two positions, either presses the main

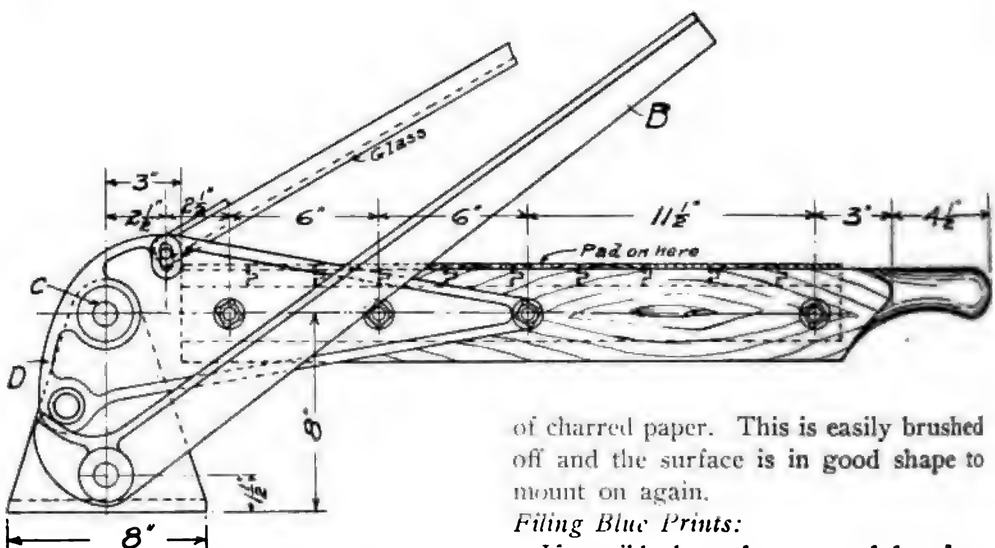
Fig. 1—Blueprinting Machine.

frame up, or is locked in a neutral position, giving no pressure upwards.

It is opened from the front by pressing down the two handles A, this throws up the two counterweight levers B and puts the pressure directly on the main pin C, the frame being at rest.

To close the frame, pull up on handles A; this brings the cam lever B so that it has a right angle thrust on main frame casting D and in this way lifts the glass up with it.

Note that the steel frame that carries the glass is hinged in a slotted hole in D; this allows it to take a correct flat position.



With the frame as detailed and two arc lamps, blue prints up to 24" x 36" can be made; it takes 50 seconds to make one with rapid paper.

Mounting Blue Prints:

For mounting blue prints, the writer has used the following method and found it very satisfactory for drawings from 9" x 12" to 24" x 36".

Use 1-32 sheet steel to mount on and cut to 2" larger than the blue print each way; then have ½" turned back all around and pressed down flat and the corners rounded off about ½" radius. this leaves a 1" margin all around after the blue print is mounted.

To mount, first wipe off the sheet steel with a bunch of waste wet with alcohol, then give the blue print a coat of shellac on the white side, then the steel a light coat, place the blue print in position and press all air out from under with a light pine paddle, let dry and then coat face with white shellac and you have a mounted drawing, good for years, if necessary.

To remove the print from the steel, hold the sheet over a good hot forge fire and it will burn off, leaving a slight coat of charred paper. This is easily brushed off and the surface is in good shape to mount on again.

Filing Blue Prints:

If possible, keep the mounted drawings in the drafting room or near by and check out from there.

Use the sectional case plan for filing the mounted blue prints and keep these as near a size as possible.

A case 4 foot long may be divided into twelve partitions by ¾" boards. The reason for using heavy partitions is on account of stacking up the cases one on the other and using sheet steel, there will be a great weight to support.

In designing and arranging cases for filing blue prints, there is one very important item to consider and that is, make

ase such dimensions as will allow umber of the drawing to come to the le upper corner when filed.

is allows the boy to handle the ngs just rocking them over to find eet wanted and the number will be y seen.

course, one might say, why not the numbers on all four corners, but average practice is to put them on nal corners, if the case is made corhe number will be at the top either lrawing is put in, except in the case square drawing which I think is n used.

ting Out of Blue Prints:

order to check out drawings, the as tools are from the tool room, it is necessary of course to have place to put the checks and like the ted drawings a good place to keep these is in a sectional case.

A case (or cases) 15" deep by 18" high and 4 foot long, divided into three sections with 14 drawers in each section, will accommodate 100 checks to each drawer.

These drawers or rathers trays are nothing more than a flat board with fronts about 1" high and brass knobs for handles.

On these boards paste a blue print with 100 numbers on it. The method of making this is to take a piece of tracing cloth the size of the space to be used and cut out 100 small squares of detail paper of such dimensions that when pasted on the tracing cloth, there will be about ⅛" margin around every square.

Use this to make blue prints from and you will get white squares with a blue dividing line.

Cases for Blue Prints and Check Tags.

Print the drawing numbers on these white squares and also the size of drawing, so when a blue print is called for, the boy can tell just which case to find it in.

For pins to place the checks on, put in small brads, as follows: Take a piece of good hard pencil eraser and make a hole through one end large enough for a brad to go through and use this as a jig; cut down the rubber to 3/8 or any height the brads are to project, place the brad in the hole, hammer it in till flush with the rubber and so save your fingers and at the same time get the pins a uniform height.

With oak fronts and brass knobs, this makes a very presentable case and made on the sectional plan can be extended as the drawing numbers increase.

Uniform Design of Reinforced Concrete.

BY LOUIS F. BRAYTON.

Reinforced concrete, although the most popular form of fireproof construction at the present day, is a veritable chaos as to its design.

Quoting from a recent publication: "Many systems are patented and it is a common matter for designs to be furnished free, contingent on the designer's patent being used."

This seems to be an unnecessary state of affairs. Reinforced concrete should be standardized. Structural steel construction has been standarized until all mills roll the same sections. Standards devised by the various steel companies are practically uniform. There are no patents to speak of, and all designers uniformly adopt the standard sections rolled, and specify the uniform connections.

There is no reason why reinforced concrete should not be brought to the same state of uniformity.

It is true that there are at present a great variety of so-called "systems" which have more or less merit, but it is also true that perfect construction can be and is every day being devised, which is not using patented forms or methods.

Standard methods should be adopted in such a form that the architect engineer or contractor, is made entirely independent of the so-called patented "systems," and at the same time the standards should be so arranged so that where it is shown profitable, a patented section could be substituted for the reinforcement shown upon the plans of the designer.

Until some systematic action is taken to standardize reinforced concrete, designers will be handicapped by the necessity of specifying some particular "system" or leaving the plans open for a free-for-all scrap as to who can do the work for the least money.

THE ARCHITECT AND REINFORCED CONCRETE.

"What is the position of the architect today?" This question has been asked by nearly everyone in the profession. Is the architect to be the agent of the contractor, is he to be crowded out of the business by those who "design and build," or is he going to maintain his old prestige and stand firmly for his rights as to the character of the construction which is going into the building under his management?

These questions must be settled at once and for all, and if the architect is to maintain his self respect and the confidence of his clients.

At the present time there are comparatively few architects who undertake to show upon their plans the methods which must be followed in the construction of the reinforced concrete portions of the buildings under consideration. It is explained that the good methods are all patented and it would be wrong to show any one system. This is true only

extent that no contractor should given a preference by the specifying his system. "There are just good the sea as have ever been caught," e architect should assert his indece by showing upon his plans e knows to be a good form of conon, and free from patent royalties.

may mean considerable study to but to those who prove themselves e it will mean a restoration of prest now enjoyed by many.

petition, where cost is to be the g point, and design the battle l. is, to say the least "penny wise ound foolish," if not actually ting to criminal negligence.

re designers are to be awarded a ct for producing a design costs money than any other, it is needsay, that one will probably be d in which the insufficiency of ma- s the principal source of economy. nerous examples of failures, often ng in death, have proven the wise pound foolish" principle in ethod of procedure.

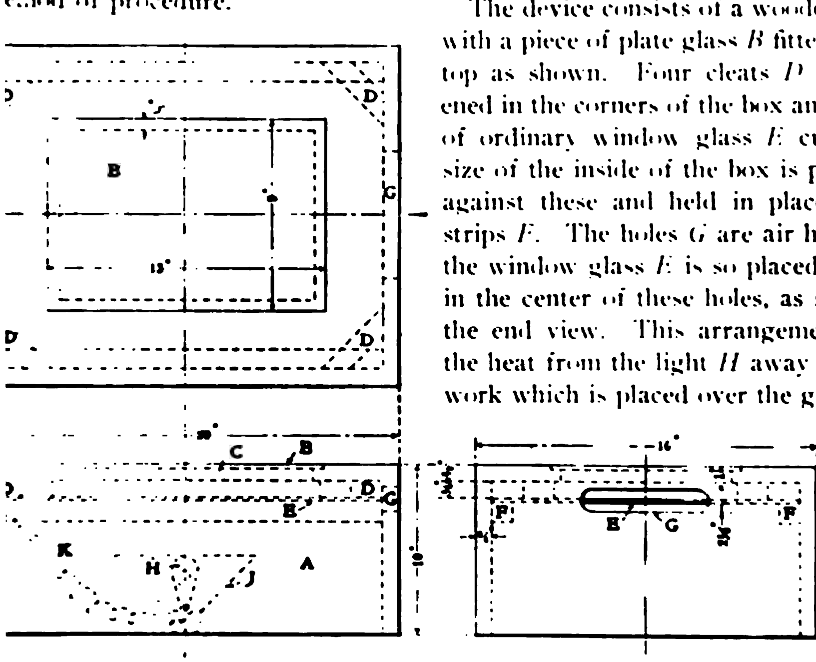
Architects should keep before their minds the fact that they are held professionally and criminally responsible for designs under their supervision and that no amount of bonding of a contractor will excuse them from not knowing that a design is incorrect.

The only safe, professional, and self respecting method to follow, is for the architect himself to educate himself to a position where he can design as he would in structural steel and permit of no tampering with his designs in the interests of economy, in any way which would decrease the stability of the structure or jeopardize his professional standing.

A Drawing Board for Patent Office Drawings.

In the accompanying sketch which was sent to *Am. Machinist* by Mr. B. R. Judd, is shown a style of drawing board which has been found very useful for making final patent office drawings from original drawings, as it saves much time and unnecessary laying out.

The device consists of a wooden box *A* with a piece of plate glass *B* fitted into its top as shown. Four cleats *D* are fastened in the corners of the box and a piece of ordinary window glass *E* cut to the size of the inside of the box is placed up against these and held in place by the strips *F*. The holes *G* are air holes, and the window glass *E* is so placed as to be in the center of these holes, as shown in the end view. This arrangement keeps the heat from the light *H* away from the work which is placed over the glass plate



A DRAWING BOARD FOR PATENT OFFICE DRAWINGS.

B and at the same time makes the task of copying the work as easy as though tracing cloth were used instead of thick patent office paper. The light used can be a small incandescent light with a reflector *J*, running the wire *K* in through one of the holes *G*.

This device may also be found useful in tracing blueprints and other similar work.

Wrought Bends in Piping.*

BY J. A. MILLER.

It is only a few years since the old time piper made all bends on the job. The pipe used was rarely larger than 2 in., and the ability of the piper to put crooks and turns in a line of piping was, under the circumstances, remarkable.

Wrought bends will save money, not only in the erection of a line of piping, but in operating cost.

As to first costs; a long sweep extra heavy cast iron ell, two extra heavy companion flanges, two corrugated copper gaskets, two sets of bolts, cutting two threads, and the cost of making up two joints, for a 10-in. pipe will be close to $30. To carry the above sized line around a corner, (Fig. 1), it will take 18 ft. of pipe to measure 10 ft. each way in the run, allowing for the ell; the same piece of pipe formed into a bend with the proper radius of about 8 diameters will reach a foot further along the line than the same pipe does with the ell, and the entire $30 for the two points is saved, less the cost of beanding the pipe. ($8 to $10).

Besides, a saving is effected in the cost of covering the piping, as well as the risk of blow-outs at both sides of the ell or the rupture of the ell itself. The contraction and expansion of a line of piping may increase the strain on the elbow far in excess of its factor of safety.

With modern piping it is now possible to have a number of pieces of any si welded together, obviating all troub with joints, as well as the actual risk their use. Such welds can be made mc cheaply than ordinary joints. Fig. shows four random lengths of pipe ma up into one piece about 80 ft. long a making a 45° bend near each end; t will reach as far around a corner in line of pipe as five lengths of pipe w an elbow at the cover. Such bends m be made of two or three welded leng of pipe and shipped easily in lots open cars and at an enormous savi over the use of ells, flanges, and or nary fittings.

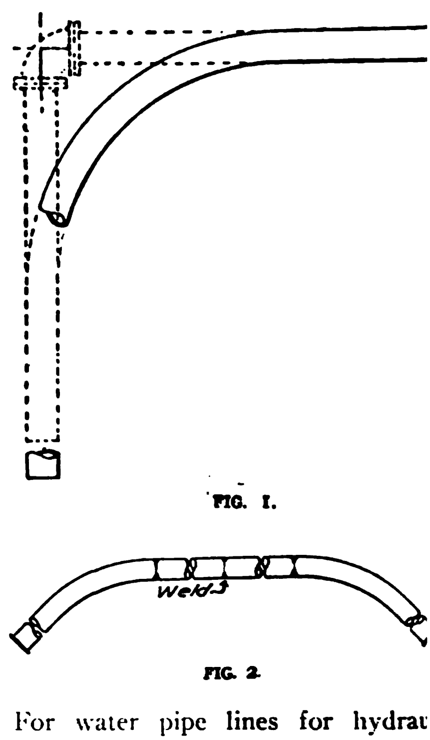


FIG. 1.

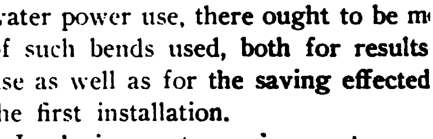


FIG. 2.

For water pipe lines for hydrau work, about mines and for high he water power use, there ought to be m of such bends used, both for results use as well as for the saving effected the first installation.

In laying out a pipe system w wrought bends it is im[illegible] to the largest radius [illegible]

times the nominal diameter of the s a good rule for the radius and a larger radius can be used. Bends early always be used with random s as to the distance from center of an to one end or both ends of the The straight pipe used in connec- with the bend can be cut readily to t to cut the ends off a piece of pipe read it after it is bent is an alto- different proposition.—*Eng. and g Journal.*

Blueprint Specifications.

en a number of copies of specifica- r other paper are wanted, and none ordinary methods is convenient or ble, make blue-prints from the ritten sheet, suggests a correspon- of the *American Machinist.*

ite the matter out on the typewriter, g a piece of carbon paper in back sheet, to give the printing density th sides of the paper, then pro- with the blue-prints in the usual er Use manifolding paper, the called unglazed onion skin. For prints use new carbon paper and the prints from that, in which case tters will appear on a white ground. arbon paper is more expensive than hite paper.—Ex.

To Straighten Tracing Cloth.

writer in *Machinery* says that the ng cloth when it comes from the r is rolled with the glossy side in- but if unrolled much of the elas- will be taken out of it and the ings will then lay flat.

Draftsmen's Organization that Failed.

BY A. EDWARD RHODES.

out ten years ago some of the men living in one of Pennsylvania's large eastern cities, feeling somewhat after the fashion of the Pencil Pushers, who write so well in favor of a drafts- mens' organization, decided to form a club.

Invitations were sent out, and a meet- ing held, with twenty-eight draftsmen from Pennsylvania, New Jersy and Dela- ware present By unanimous vote is was decided to organize a draftsmen's club for social and educational improvement. Then followed a series of meetings at which there was long and much unnec- cessary squabbling over by-laws and mat- ters of little importance, which, neverthe- less, consumed much valuable time, created dissensions, and disgusted many who would have made good members. This long controversy over by-laws makes it evident that in forming an or- ganization it will be wise for eight or ten draftsmen to meet and draw up by-laws, and not make too many. Let them set- tle everything, officers and all, and when they invite new men to join, they, the new men, will understand just where they stand and what to expect; also there will be left nothing except the GOOD OF THE ORGANIZATION to cause discussion. As the new members come in they can be assigned to the various working committees, and everything will move harmoniously. In the club men- tioned, many of the leading spirits be- lieved that the life of the club depended upon their ability to obtain a costly permanent home where the members could meet together frequently, and where open house for visiting draftsmen could be found.

It was impossible to accomplish this, however, until a large membership was obtained, which was never done. Some draftsmen not approving of an organiza- tion so expensive to the individual mem- ber, and other draftsmen knowing of the failure of an attempt to organize, by

other draftsmen, a few years before waited to see whether the results of our endeavors would be more fruitful. The, shall I say, unconscious influence of these two sets of men who witheld their support in the beginning, not only materially crippled the efforts of those most zealous for the welfare of the club, but also restrained others from lending their aid.

The question of securing and furnishing a home was an important consideration with us, and three schemes were proposed for its accomplishment. One that was defeated practically without consideration, was to rent a furnished room for two nights a month. Another was for a number of the more zealous members, who felt able to pay annual dues of $15.00 to form a club, furnish it, and allow the general organization to use the rooms for a nominal sum. This did not prove popular for obvious reasons. The last scheme was to issue bonds in five and ten dollar lots, to be subscribed for by the members. By this time, almost a year of differences of opinions, nothing doing, except, as in modern phraseology we term, heated atmosphere, the attendance began to decrease and finally the organization came to an end.

REASONS FOR FAILURE.

1. A determination to have rooms, and to do things that only old established, and strong financial organizations can do.

2. Many members having a pet fad which must be made the prime reason for the organization's existence, or I will do all I can to prevent its success. Some actually did.

3. Wasting much valuable time in long unnecessary squabbling over by-laws and other matters of little importance.

4. A class feeling against foreign born draftsmen.

5. The fact that a previous attempt to organize had proven a failure, had the effect of causing many to withhold their support until they felt assured of a successful issue.

Now as to the formation of a draftsmens' association, I believe it is well recognized that no profession was ever more in need of a society or fraternal organization. It also seems to me that as the editor of *Browning's Industrial Magazine* is, perhaps, in touch with more members of the craft than any other person, he is the one to do the preliminary work. I take the liberty of suggesting that he write to a number of draftsmen whom he may know to be interested, request them each to submit a set of by-laws. These may afterwards be rearranged to form a composite set embodying the features submitted by the above draftsmen living and working under different conditions. *Browning's Industrial Magazine* could then print the by-laws, with a request for the names of draftsmen willing to organize, or join a local organization.

Obviously there are many details that will develope and require much work on the part of the organizer, and his committee.

Shall We Organize?

Our circumstances as draftsmen depends somewhat upon our surrounding conditions and our destiny, greatly upon that which we wish to make it.

The foundation for us to build upon to succeed with our work, is to have self-reliance, with confidence in those about us and an interest in the profession, and all, housed within the walls of a society. Are we too busy that we cannot take time to look about us, to see if something cannot be done to make the task easier, to encourage a brother, and make our drafting methods more beneficial? Here we are, a body of a [illegible] draftsmen, of all

this land, each one hustling "mainly for himself," and surely there are some out of this number, who are willing to join hands by organizing a national society of draftsmen.

The Editor has been very kind and energetic in our behalf by publishing several articles and constitutions, and he has otherwise made it possible for our organization through the medium of this magazine.

We see in the April issue a call to send delegates to meet at Cleveland soon. It behooves every draftsman to avail himself of this opportunity or to express his views.

A society will give mutual improvement and many advantages that we cannot obtain in any other manner.

The success of one will be the success of the other, and all linked together in that success. May each one have courage to believe in himself to do something worth while for the profession, and a determination to help organize it.

Yours respectfully,

A. B. HAYES.

Milwaukee, Wis.

Recent Inventions.

Specially reported for Browning's Magazine by C. LeRoy Parker, Solicitor of Patents, 630 F. St. N. W., Washington, D. C., to whom all correspondence with reference to this matter should be addressed.

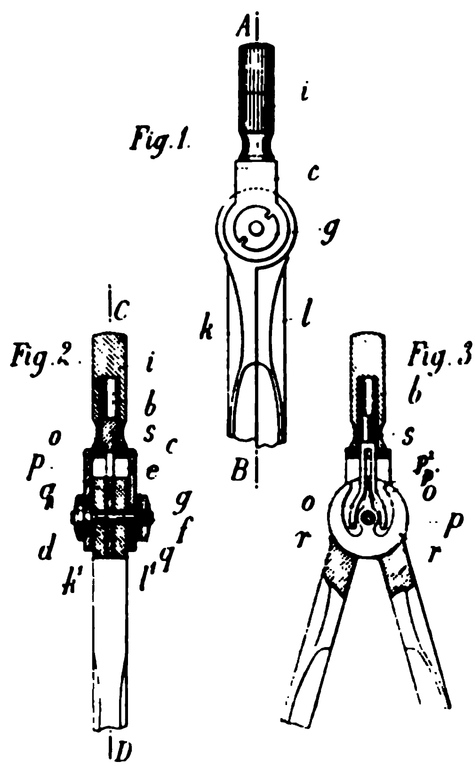
COMPASSES.

No. 814,453. March 6, 1906.

Heinrich Kern.

The recently patented invention shown in the accompanying illustration relates to compasses and similar instruments such as dividers, calipers, etc. The principal object of the invention is to provide in i[illegible] [illegible]merated in which the stem handle is always maintained in a vertical position with relation to the working surface of the drawing.

In the use of the device the stem handle forms the same angle with the legs irrespective of the degree of separation.



The handle in this position with relation to the device is always maintained perpendicular to the plan of the drawings by virtue of a forked spring mounted in the handle and extending downwardly so that its legs overlap on each side a rigid spur carried by a stationary pivot plate.

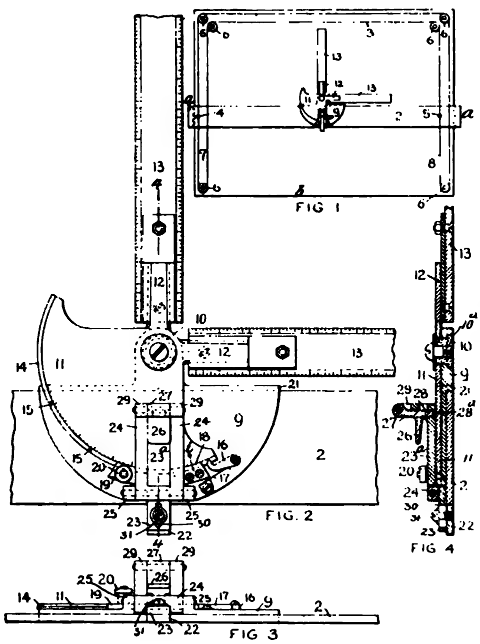
DRAWING AND PLOTTING DEVICE.

No. 814,789. March 13, 1906.

Edward D. Mackintosh.

In the accompanying view a novel drafting instrument is shown, which has been recently patented. This invention embodies a drawing and plotting device in which a movable support is employed

that is provided with one or more adjustable rulers or straight edges. The brackets in which the straight edges are supported and the support for the structure as a whole are so assembled that



when the parts are adjustably set, the movement of the support in a direction parallel to a predetermined line is assured.

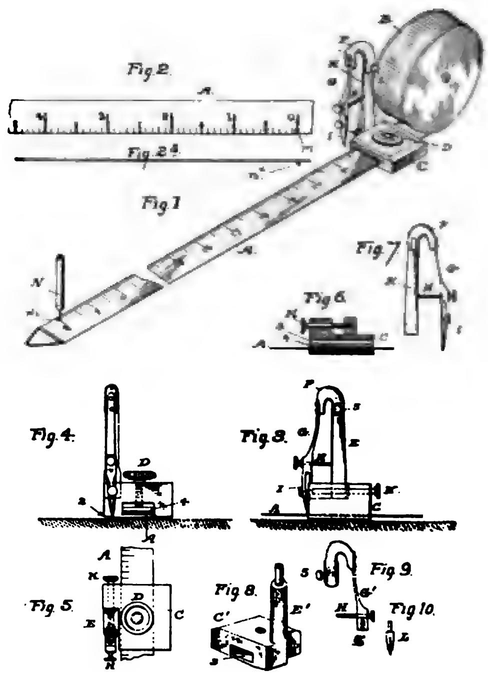
BEAM COMPASS.

No. 812,322. Feb. 13, 1906.

Thomas N. Badger.

In the accompanying illustration a novel beam compass is shown which has been recently patented and the essential features of the instrument are a thin beam adapted to lie flat upon the paper and an adjustable holder capable of supporting or holding a pen or pencil in a position generally perpendicular to the beam, the holder being movable upon the beam and having means for clamping or fixing it at any desired point in the length of the beam, together with a means for holding one end of the beam at the center from which the arc or circle is to be struck and around which the beam is freely movable.

In describing an arc from a given center the beam is held at one end at the center by fixing a needle-point N, as shown in Figure 1, into the drawing board through a small hole made in the



steel tape or beam A. This hole m is located on the zero-mark of the beam, so that the required measurements are accurately read and determined from that point.

SLIDE-RULE.

No. 813,485. Feb. 27, 1906.

B. D. Coppage.

The accompanying view illustrates a new departure in slide rules. As shown the device comprises a straight transparent cylindrical tube, a split cylindrical tube, with scales thereon, fixed within the transparent tube and a straight slide in the split cut having a side, with scales thereon, equivalent in width to the chord of the missing arc of the fixed scale-tube. The device is

ator clamps the tube for about two [hun]dred and seventy degrees, having a [por]tion concentric with the exterior of [the] tube, from which extends tangential [por]tions which are off-set radial to said [tub]e to receive an eyelet rivet, which [join]s the ends together. By grasping the [eye]let between thumb and second finger

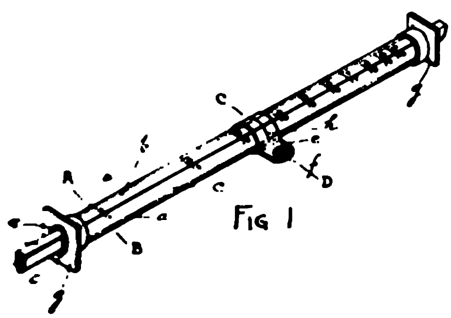


Fig 1

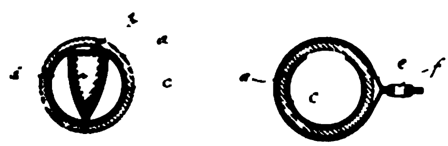


Fig 2 Fig 3

[an]d placing first finger back of the loop [th]e riveted portion can be pressed to[w]ard the tube, causing the tangential [port]ions to act as toggles, which force [fro]m the portion of indicator which [grip]s the tube. The indicator can then be [eas]ily moved. Upon releasing the grasp of the fingers the indicator will be secure in any position. The indicator may be made in the form of a split cylinder having the desired frictional fit upon tube a.

A Pneumatic Eraser.

A typewriter eraser has been devised by The Pneumatic Eraser Co., Owensboro, Ky., in which a bulb is attached at one end and the eraser has a hole through it connecting the bulb.

The device is held as an ordinary eraser with the bulb under the palm of the hand and by pressing slightly a current of air is forced through blowing away the dust.

It will in this way avoid the use of moist fingers which often smear the work. No doubt it would work well on tracings. Price is 25 cents.

Civil Service Examinations.

The U. S. Civil Service Commission announces an examination on June 13, 1906, to secure eligibles from which to make certification to fill vacancy in position of engineer and carpenter at $900.00 per annum, in Indian service at Winnebago, Neb.

Also for Mechanical Superintendent, Bureau of Prisons, Manila, at $2,500 per annum.

QUESTION BOX.

This department is in charge of Mr. A. B. BABBITT, Hartford, Conn., and questions will be answered [pro]mptly if sent directly to him. The department is intended to give correct answers to questions of general interest. Make your question complete. Name and address must accompany each query, although [no nam]es will be published.

[1]2. Is there a book on the market telling how to figure out angles, degrees of [cur]ves radii, cos., cot., etc., on railroads?

We think that Trautwine's "Civil Engineer's Pocket Book" will give you the information you desire. (This may be obtained through the Browning Press, if [you] choose).

[1]4. Will you please explain the difference between one-half scale and one-half size?

These are synonymous terms. The term, "Scale: One-half Size" is used to show that the drawing is one half the size of the object represented. Should the term "One half Inch Scale" be employed, it means that each one half inch on the drawing represents one foot on the object represented. The latter term is often used in conversation, but the following is generally printed on the drawing, "Scale: ½ inch = 1 foot."

The Follies of Some Foundry Superintendents.

BY THOS. WATHEY.

I do not know whether it is ignorance or stupidty on the part of some foundry superintendents in regard to the mixtures of sand for certain purposes.

I will give you an instance that came under my observation of a foreman that had been with a concern for some time and became a superintendent of another plant.

The shop he came from was doing a good class of work in green dry sand and loam moulding, but somehow when he took charge of the other foundry, all of his loam castings were scabby and there soon accumulated a large pile of bad castings outside the shop as high as they could place them with a crane.

I thought that he would have broken them up but instead they accumulated until there were no other place to put them.

Perhaps he did not get the same request as I did at one time from the manager of the foundry of which I had charge. He said, "Tom, I have seen a bad casting out in the yard the past two days. Why don't you have it broken up? We do not wish to be looking at our misfortunes all the time. Put it in the cupola. It is a good plan to get this eye sore out of the way as soon as you can."

It surely is not for want of experience on the part of this superintendent, for he had been foreman of this other foundry for nearly 20 years. He evidently had knowledge enough or should have had, but he kept on experimenting with the loam all the time, and in one case had used six different mixtures in one job. A good loam moulder can tell what it is as soon as he has put his hand in the mixture. Now what impresses me so forcibly is that when they have had so much experience in loam moulding and making such good castings, why they did not use the same mixture.

There is no excuse that he couldn't get the same kind of sand for the country is full of it, but one of the causes is on account of the height of the oven which was said to be about 20 feet. This would cause the moulds to dry on top and be wet on the bottom and a loam mould should be thoroughly dry before casting to make a successful job. Even small castings with about 3 ft. of surface were the same.

Here are two mixtures that have been relied on to give good results for dry sand: Three of mould sand and 6 of sharp sand with sufficient core compound to make it workable. I have seen fire right on the mould for some length of time and it did not burn it as it would with other mixtures.

For loam, 3 moulding sand, 6 of moulding sand, 1 of manure mixed with thin clay wash.

The Placing of Pipe Unions.

The Browning Press, Collinwood, O.

Gentlemen: Your article on the Layout of Piping in the March number prompts me to make a few remarks relating to unions and the placing thereof. In laying and connecting piping it is always desirable to avoid the use of too many unions, but at the same time a sufficient number should be introduced into the piping system to provide for changes that now and then becomes necessary and to allow of connection being made without unnecessary delay. Unions improperly placed may become a constant source of leakage especially so if placed on pipes with rigid end connections, of course on lines of any considerable length an expansion joint should be introduced unless the pipe is of small size and laid in such a way that the expansion

p by the "spring" or flexibility nnections. Great care should ed, however, where cast iron e used, as the combined strain pressure and expansion may n to burst. Cast iron fittings in ould be used only on low pres-, they are convenient to use in ere piping must be renewed, as they can be removed by hem with a few blows of the In the sketch shown it would ble to place a union just out-e check to provide for taking off without ripping up the en-n. If the upper (Supply pipe) d to the boiler by a flange no n would be necessary, assum-urse, that the plant is a small licated by sketch.

Respectfully yours,

C. M. CALLANAN,

No. 216 N. Division St.,

Buffalo, N. Y.

---

my in Tramway Tracks.

LS MADE AT COMPARATIVELY SMALL EXPENSE.

Hamm, of Hull, sends the fol-scription of a demonstration eeds, England, of a simple yet l invention connected with the rack: The present method of amrails is to make them in one-ths. It is only the upper sur-n receives any wear, and when rn out the whole rail and con-ave to be torn up, and a totally ment put down. The invention the rail into two parts—sepa-wearing surface from the per-rder support. It allows of the f the wearing surface when without pulling up the whole dway or interfering at all with the under girder, which is tied down to the concrete bed. Under this system the renewing of tramrails apparently becomes as easy as resoling a worn pair of boots. The invention is not in the rails, but in the machine requisite for combining the two sections effectively. One locomotive carries the three machines that are neces-sary, one machine for rolling on the up-per rail and two for cutting it off when it is worn out. The wearing portion of the rail fits down over the lower portion, the rolling-on machine bending the de-pending flanges inward so as to grip the supporting rail. These depending flanges are converted into cold-rolled springs, with an inward grip so intense that at a test made by the Sheffield Test Works the adhesion of the top section to the bottom section in a length of only 1 foot was found to be 23 tons. The cutting machine cuts a groove into one of the depending flanges of the rail to a depth of one-third or half the thickness of the metal, while the breaking-off machine applied to the two flanges breaks off the partly cut flange, thereby releasing the head rail. These operations do not in any way injure or disturb the under T section.

If each time a renewal of the rails is necessary the cost of taking up the whole of the track is avoided there must be a great saving, and the general manager of the Leeds tramways estimates this economy at 53 1-3 per cent. Another great advantage claimed for the system is that the work of renewals can be done very speedily at night and involves so small an amount of material on the road that the traffic is very little interfered with.

It is said that oil or fat will destroy Portland cement, causing cracks and even disintegration in a few months' time.

INDUSTRIAL NOTES.

Some flags laid in 1861 in London were subject to a daily average traffic of 46,000 persons and were thoroughly worn out in 1884.

Among trees the elm reaches an age of 335 years; the ivy, 450; the chestnut, 600; the cedar, 800; the oak, 1,500, and the yew, 2,800.

Winsted, Conn.- Miss Clara Smith, who lives with her brother, William Smith, on the Northfield road, in Thomaston, has invented an auger that will bore a square hole. She is of ingenious mind, and carpenters say there is a fortune in it for her

Counsul Hannah, writing from Magdeburg, says that the Verein der Deutchen Zuckerindustrie has offered a prize of $2,380 for a machine that will solve the problem of satisfactorily digging beets and heading them at the same time.

Dr. P. E. Shaw, of the University College, Nottingham, Eng., has completed an apparatus making it possible to measure the one seventy-millionth part of an inch, and which will prove of great use to scientists in their researches.

The Brazilian Government has appropriated $80,000 for carrying out surveys and other works in order to develop the coal mines of Brazil. The matter is in charge of the Ministry of Industry, Ways of Communication, and Public Works, at Rio Janeiro.

Daily consular reports of February 13 contained my report on the ceramic product known as "calcium steel," which is made of finely pulverized feldspar, sand, and lime into a paste and baked in an oven. The product is an earthenware of great hardness and durability, the calcium contained in the feldspar giving it the name "calcium steel."

The Baldwin Locomotive Works, of Philadelphia, have just contracted to supply 20 engines to the Italian State Railway, delivery to be made during the coming summer. The machines will be of the American type, 10 simple and 10 compound, with slight modifications as to weight and fittings to meet the necessities of the lighter Italian roads.

Consul Smith, of Victoria, writes that the Minneapolis syndicate which purchased 43,000 acres of fir and cedar lands on Vancouver Island estimates the land to contain a billion feet of lumber. The company proposes to build a mill with a capacity of 40,000,000 to 70,000,000 feet per annum. A railroad will be built to the coast, and the company will operate its own fleet of tugboats.

Consul Ravndall writes from Dawson that work has been begun by the Canadian authorities blasting out the rocks which impede navigation up the Fortymile river from the Yukon. As a result the work of the miners on the American side will be greatly benefited; but Canada will get the trade of the mines, which in the long run is worth by far more than the gold that comes out of the ground.

An extension of the wireless telegraphy system of Lower California is reported by Consul Kaiser, at Mazatlan. The machinery installation will be made at San Jose del Cabo, at the end of the peninsula, and at the port of La Paz, in Sinaloa, by a German company, which secured the contract, and will install benzine motors with cooling machinery, continuous-current dynamos, storage batteries, etc.

CURRENT TOPICS.

hange in the make-up of our read-
iges may be noted in this issue, also
: headings Some more improve-
will appear in the July issue, per-
more pages.

: mechanical department has been
ted by the addition of an improved
ng machine which insures a much
· binding.

s machine has a capacity of from
ieet to about 7/8 of an inch so that it
isily take care of any increase in the
iess of the magazine.

---

re is a sample application just re-
l.

emen:

iw your Add in todays Star. Am
ars of age was raised with an en-
ny Father being an engineer am at
it unemployed."

Yours very truly,

William Wilson.

---

ter the recent shake-up in California
of the first calls for help in rebuild-
as for draftsmen.

chitects were rushed to get out plans
nprovement and new buildings.

---

e march of concrete goes on, there
s to be no limit to its possibilities.
ieers are producing month after
n new wonders in this line of con-
tion. Of course, all of them are not
what the artistic sense demands, but
must be a beginning in all things.

A New Type of Engineer.

e other day a firm of contractors
· the editor of an engineering jour-
nal, asking that he recommend a "cost-analysis engineer."

They want an engineer who has had considerable field experience and one who has a good knowledge of costs. This engineer will be put in charge of their cost keeping department and will be called upon to estimate on future work.

There are not many cost-analysis engineers in the country, if we mean by that term to designate civil engineers who have made such a thorough study of costs and cost-keeping as to entitle them to be called specialists.

The field of activity for engineers as employees of contracting, or as contractors themselves is greater and better than ever.

The day of cost-analysis engineers has come.

Hiring Transient Help.

Some foremen have a custom of giving preference to an outside workman over their resident workmen. There are times when a good boy is started in on a small job at \$2.00 or \$3.00 a week, and he will be very diligent in his work and push himself up until he is not only capable of, but is actually doing a man's work, and after working for several months for a boy's wages, doing a man's work, it is natural for the young man to feel that he ought to have an increase in wages, and sometimes after asking for an increase he will be given a very small one. Now this young man was doing the work of an ordinary man who was earning \$12.00 or \$14.00 per week, and the young man doing the work satisfactorily, too, for a few dollars per week. Then,

to think of only receiving an increase of fifty cents or a dollar on the week, makes him feel discouraged, because he knows as well as anyobdy ought to that he is not being paid fair wages for the work he is doing. But he keeps on with the work and finally feels that he ought to say something about an increase again, so he accordingly asks that he be given as much per week as was paid the man who previously did the work; but for some reason or other the foreman thinks or feels that the young man is trying to bluff him, so he does not give him the amount asked for and the young man resigns his position. Then along comes one of these transient workmen, possibly from a large city, and experienced in the work that this young man has been doing. Without regard to the man's habits or character he is asked to do this work, and instead of telling him the amount he will be paid for doing the work he is asked what wages he would want for doing the same. The applicant, of course, will not do the work for less than has been paid an experienced workman, so the foreman puts him to work and he is paid $12.00 or $14.00 a week for the work, and the quality of this man's work is far below the standard of the young man's whose place this journeyman is filling.

There are cases when a workman will try to run a bluff on the foreman and demand higher wages, but in a great many times it is not a bluff and the person asking the increase is simply turned down and the foreman will turn around and pay a stranger just whatever he asks.

The merits of the young man who has worked his way up in the factory should be recognized and pay him a reasonable salary for his services.

Personal.

Mr. Clark W. Combs, Washington, D. C., inventor of Sheet Separating, Feeding and Guiding Appliances, Patent 677,062 and of overlay patent 809,095, Printing Machinery Labor ing Devices, has commissioned Thomas F. Hanlon to incorporate ganize and finance the Inventor's Co.

The company will manufacture exploit these inventions for comm purposes; also buy and sell and de inventions and aid other inventors financial way if necessary.

Mr. Hanlon may be addressed at 1736 "G" St., S. W., Washington, 1

Catalogs and Books.

The catalog of The Monong Mfg. Co., Monongahela, Pa., bears inscription: "Built for Work," and t is no question but that they are buil work. The booklet describes the equipments that this company is prep to build, with many working diag of shears and stands used in haulage tems. This company undertakes to de and equip the outside workings of tuminous coal mines, furnishing hau engines, tipples, cages, mine cars, cr ers and special machinery for economical handling of coal.

The Harris Patent Power Hoist Carrying Machine manufactured by S. Harris Co., Rome, N. Y., is descr in their catalog as being an overh trolley system with automatic cont The machine is fastened to the cei and is shown to hoist and carry the l along a straight line, the trolley runr on a track.

"Fifty Plumbing Charts," show how modern sanitary, up-to-date plu ing should be done. The charts sl sizes of pipes, height of all fixtures, e piece and every fixture used in all ki

of a job. Price 25, is too reasonable for the information given.

Address, Domestic Engineering, Jefferson St., Chicago, Ill.

An eight page folder from The Yale & Towne Mfg. Co., 9-15 Murray St., New York, describes Portable Electric Hoists and also shows some applications of these machines.

The diagrams and tables are quite complete.

The large number of orders received for "Trigonmetry Simplified" show that there has been a long felt want for the book on this branch of mathematics which would be simple enough for the student, mechanic or draftsman who never had an opportunity to study the subject.

The tables are standard and thoroughly explained, the text is well illustrated with line drawings. The price is low, only 50 cents. Address the National Book Co., 408 Park Bldg., Cleveland, O.

Lettering constitutes a large part of the work of the draftsmen and to be skillful in this branch of the work requires much practice. "A CHAPTER ON LETTERING," published by The Browning Press, Collinwood, O., has been revised and now appears as the second edition in much better style.

Some new illustrations of alphabets have been added and the descriptive matter for the beginner in lettering has been revised Price, 25 cents.

"Designing," a tiny work containing many practical designs with brief instructions how to make them by D. L. Stoddard, author of "Steel Square Pocket Square," etc., has been received.

The author has outlined what may be accomplished during long winter evenings and the suggestions are good.

The author has also compiled a steel square pocket folder which gives a lot of diagrams relative to the use of the carpenter's square.

Both the book and folder are produced on the press of Master Joy G. Stoddard and are examples of care and thorough workmanship. This booklet is sent with the folder which is enclosed in a morocco case, with pockets for working cards, car tickets, etc., for 35 cents. Address D. L. Stoddard, 328 W. Raymond St., Indianapolis, Ind.

A great many "Pocket Books of Mechanical Engineering" have been produced but generally the volume of matter necessitates a very heavy book. Mr. Charles M. Sames, M. E., of Jersey City, N. J., has published a volume whose dimensions permit of it being carried in the pocket without inconvenience.

The several sections of the book contain data on the general subjects of Mathematics, Materials, Strength of Materials, Structural and Machine Parts, Energy and Transmission of Power, Heat and Steam Engine, including also the Turbine and the Gas Engine, Hydraulics and Hydraulic Machinery, Machine Shop Data and Electrotechnics.

This book is made up in a handsome manner, printed on thin paper, and contains the main facts of the data required in engineering calculations.

Its size and arrangement will appeal to the engineer or draftsman who has calculating to do outside of the office where other books would be unwieldy. The size is 4" x 6⅝", flexible leather binding, price, $1.50. Address C. M. Sames, 542 Bramhill Ave., Jersey City, N. J.

The catalog for 1906 of the Brown & Sharpe Mfg. Co., Providence, R. I., has been issued and contains 514 pages descriptive of their machine shop tools and appliances. The former consists of mill-

ing machines, lathes, hardening and annealing furnaces, screw cutting machines, oil pumps and accessories.

Among the latter are a great variety of milling cutters, gauges, calipers, rules, protractors, squares and scales. A copy will be mailed to any address upon application.

A Big Bundle of Books.

The Judge Co., 225 4th Ave., New York, will forward you a generous supply of back numbers of *Leslie's Weekly* with an ample addition of *Judges* and other light reading, for one dollar.

They also send a 50c bundle or a 25c bundle upon receipt of remittance. A fine collection for your money.

A New School.

The Corporation Correspondence College of Washington, D. C. is now prepared to give instruction by mail only, in the Art and Science of Incorporating, Organizing Business Corporations and financing them, selling their securities and acting as registrar and Transfer Attorney thereof.

This department, the leading course in the College, has been recognized for its merits and will be of special interest to professional men as well as financiers, promoters, real estate, insurance men and others, because they can earn money by practicing this high toned profession. It is the first correspondence college devoted exclusively to teaching this course.

The Empire School of Structural Drafting, Troy, N. Y., is sending out their prospectus of a Correspondence Course of Instruction in the Office Work of Designing, Estimating and Detailing of Structural Steel Work .

The author and compiler of the notes and problems used in the lessons is a graduate of Civil Engineering of the Rensselaer Polytechnic Institute of Troy, N. Y.

The corps of instructors is composed entirely of practical engineers and each student can feel assured that his work will be examined, criticised and corrected by men who are both competent and practical.

The course is given in thirty-six lessons and is arranged in such a manner that the student is given work to do which is identical with that of draftsmen in a structural shop.

Book Reviews.

The Signists Modern Book of Alphabets, collected and engraved by F. Delamotte contains 100 designs of plain and ornamental, ancient and medival from the 8th to the 20th century with numerals. The collection is especially valuable to architectural and engineering draftsmen, surveyors, masons, decorators, painters, lithographers, engravers, and carvers. Bound in cloth, 6x9½ oblong, with 208 pages, price $1.50, Frederick J. Drake & Co., Wabash Ave., Chicago, Ill.

Twentieth Century Machine Shop Practice, cloth, 600 pages, 400 illustrations by L. Elliott Brookes. Price $2.00, Frederick J. Drake & Co., Chicago, Ill., publishers. This book is intended for the practical instruction of machinists, engineers and others intereited in the use and operation of machinery. The divisions of the material in the book are Arithmetic, Algebra, Practical Geometry and Mensuration, Applied Mechanics, Properties of Steam, The Indicator, Horsepower and Electricity. The latter part of the book gives full and complete information upon the subjects of Measuring Devices, Machanists Tools, Shop Tools, Notes on Steel, Gas Furnaces, Shop Talks and Kinks and Medical Aid. Also over 50 tables. The book is well illustrated and the subject matter is simple and not too technical.

70 TON SHOVEL WITH 2 1/2 CU. YD. DIPPER. BUILT BY THE BUCYRUS CO. NOTE CONTINUOUS LINE OF "A FRAME" AND "JACK ARMS."

VOL. V JULY, 1906 NO. 7

BROWNING'S INDUSTRIAL MAGAZINE

STEAM SHOVELS AND THEIR USES

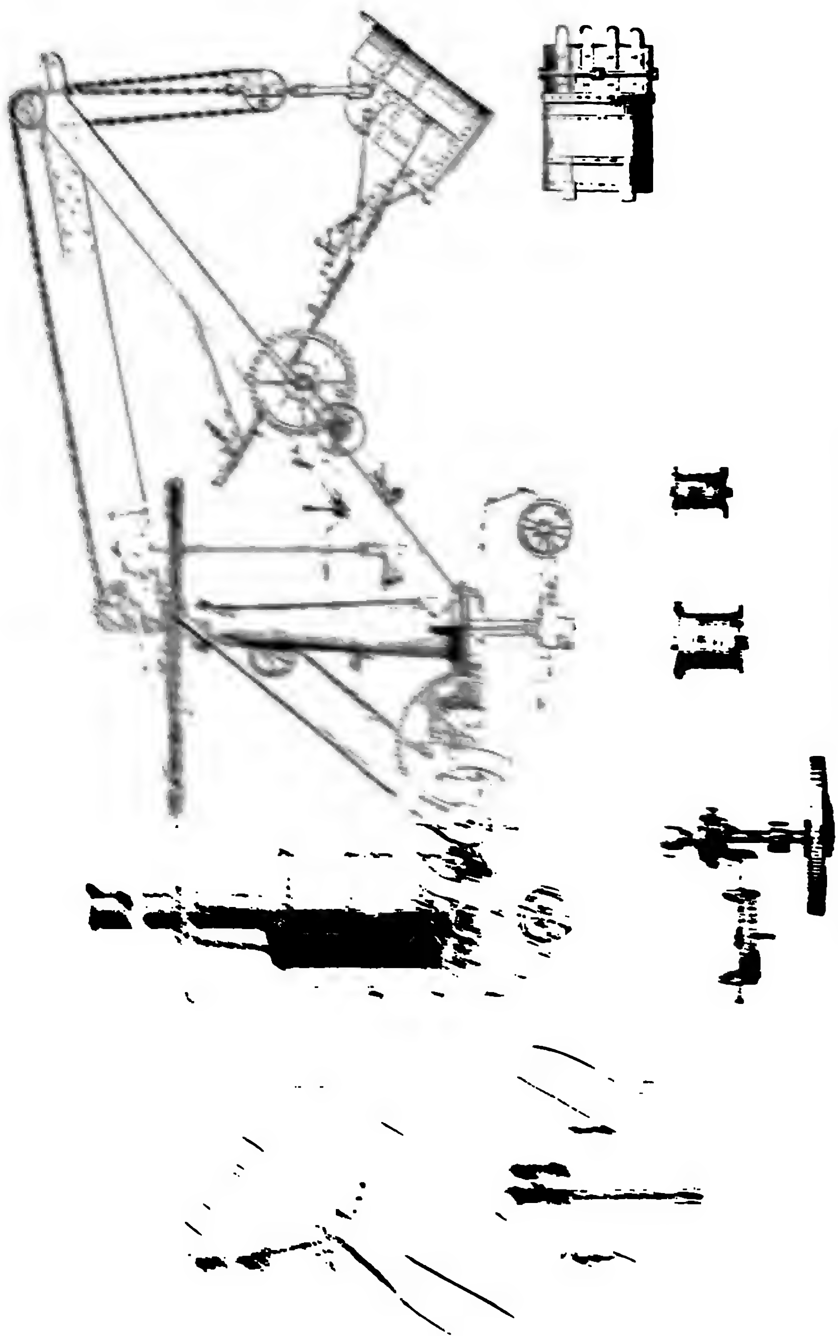
BY WILLIAM H. WAITE.

THE first practical Steam Excavator, or, as it would now be called, Steam Shovel, was designed and built by a Mr. Otis, of Boston, somewhere about the year 1840. This first machine was, of course, very rough and crude, but was at the same time very effective.

By comparing the cuts of that machine and those of the present time, it would be noticed that really very little departure has been made from the original design. As is to be expected, the shovels of today are great massive machines, but they all work with practically no change in operation from the original design.

In spite of the effectiveness of the first shovel, very little was done along this line until about 1865. At that time the great strides made in the building of new railroads created a demand for the steam shovel, and several companies began to devote almost their entire time and energy to their manufacture.

From then on the demand for the shovels grew steadily, but rather slowly, until the Chicago Main Drainage Canal was planned. The digging of that has probably done more for the education and development of the American contractor and his machinery than any other single piece of work.



Original Shovel as designed and built by Mr. Otis.

Over sixty shovels were used on the Drainage Canal, and as each manufacturer was well represented, and took the opportunity of studying their own and their competitors' machines, many improvements were the natural result.

Previous to 1886 the car bodies and cranes were built almost entirely of wood, but the extraordinary demands made upon them naturally led to the use of steel, first for the crane and then for the entire machine. As they are now built, wood enters into the construction only as sides and roof for the enclosing house, and even that is being gradually made of steel.

In its simplest form the orthodox steam shovel consists of a car body mounted upon suitable railroad trucks or traction wheels with a swinging arm at the front end carrying the scoop or "dipper" and dipper handle, and with a boiler, engines and drums on the car for hoisting the dipper and for swinging the arm from side to side.

The dipper is in form a large steel box, open at the top, and provided with teeth and a sharp cutting edge. The bottom is hinged to the back, and is held shut by a latch which can be released by the cranesman, thus allowing him to drop the load wherever desired.

First Shovel built by Thew Automatic Shovel Co. 14 years ago, and still in operation at the yards of the Cleveland Brick Co.

Fig. 1—Railroad Crane Shovel built by the Ohio Shovel Co.

Land Dredge built by Ohio Shovel Co. for use in South American placer gold fields

As originally built, the shovels were all of the "Crane" type, as illustrated by Fig. 1. In this construction, the upper and lower chords of the swinging arm are built into one rigid structure, pivoted at the inner end to a so-called mast, which is in turn held in place by a very heavy, expensive system of bracing on the car body.

The crane is made up of two sections fastened together at the inner and outer ends, leaving a space between them through which the handle of the dipper works. The outer end is provided with sheaves, over which the hoisting chain for the dipper passes on its way to the main hoisting drums.

The hoisting machinery is placed on the deck of the car, while the swinging machinery is carried on a frame above, supported by the mast bracing. In some cases, in the early shovels, the three operations of hoisting the dipper, thrusting it into the bank, and swinging the crane from side to side were performed by one pair of engines, working through friction clutches.

Railroad Steam Shovel working in blasted rock. Built by the Vulcan Iron Works Co.

Latest type of Railroad Steam Shovel. Built by Atlantic Equipment Co.

Revolving Shovel used in handling gravel near electric car line, receiving power from trolley lines. Built by the Thew Automatic Shovel Co.

The demands of today, however, are so severe that a separate pair of engines is provided for each operation, being geared directly to the part to be moved.

The Crane type was necessarily very expensive and owing to the heavy superstructure required, the center of gravity was high, and thus made the machine more or less unstable. Then again, there was a practical limit to the "height of dump" or the height over which the dipper would clear with the door open.

All of these points led to the development, about 1889, of the "Boom" type, Fig. 2, which is almost universal now, except in the smaller sized traction shovels. In this type, the swinging arm is made of a heavy double boom, pivoted at the lower end to a rotating step casting, and suspended at the desired angle by means of truss rods or boom guys, as they are called. The boom guys are journaled to the top of an "A" frame, which is carried by the car, and by back guys running to the rear end of the machine.

In the early "boom" shovels, the A frame was very high and had

to be taken entirely off the shovel when moving from one place to another, but in 1893 the Bucyrus Company exhibited a shovel at the World's Fair in which the A frame was made to pass under railroad bridges while it was in place. This is the usual practice today in all except the larger sizes, and even in those means is provided for simply lowering the A frame, instead of having to remove it completely.

The two pairs of engines used for hoisting and swinging are carried on the deck of the car, while those for forcing the dipper in and out of the bank are mounted on the boom, being supplied with steam by means of a pipe having flexible connections.

The boom can be made of almost any desired length, and can be suspended at such an angle as to give the required free height of clearance under the dipper door when open.

In order to prevent the shovels from tipping over when digging on the sides, they are provided with outriggers or jack arms at the front end, which are fitted with large screws bearing on heavy blocking, by means of which the shovel is fastened securely into position.

Steam shovels may be roughly divided into four principal classes: First, the Railroad type, in which the shovel is mounted on standard gauge railroad tracks; second, the Traction type, in which the shovel is mounted on wide tired traction wheels and is capable of being run over an ordinary country road; Third, the Land Dredge type, in which the shovel is mounted on either very wide gauge trucks or carried on rollers of some sort; Fourth, the so-called Automatic or Revolving type in which the machinery is carried on a rotating platform, mounted on a four wheeled base, and in which the dipper can be swung through a complete circle instead of through an arc of 180 degrees only, as in the other classes.

The Classes 1 and 2 are the ones ordinarily used by railroad and other contractors, and constitute the bulk of all the machines built. Class 3 is used principally for placer mining and similar work where the machine is required to dump into a hopper and where a long reach and high lift is needed. Class 4 is rapidly growing into favor for use in brick yards, cement plants, digging cellars, etc.

The machinery consists in general of a double, link reversible engine for hoisting, geared by means of a friction clutch to a large hoisting drum, from which the hoisting chain passes around various sheaves to the boom point, and thence to the dipper bail; a double valve reversing engine for swinging, geared directly to a drum, the cables or chains from which pass around a large circle fastened to the

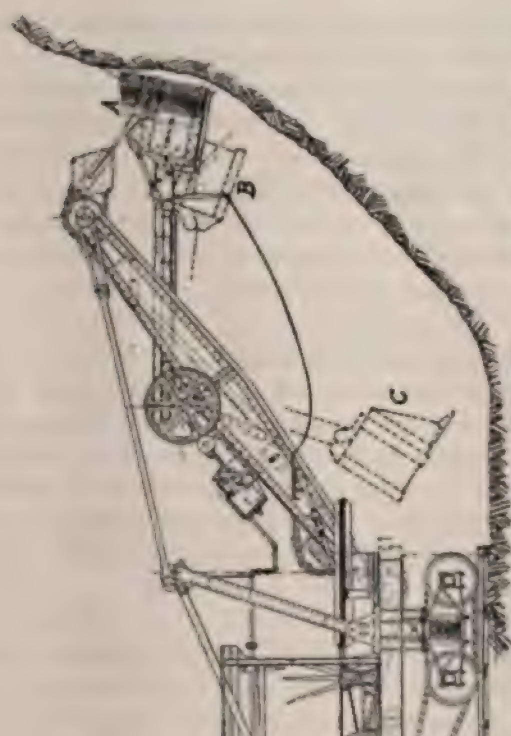


Fig. 3—Diagram showing positions of dipper at C when starting a cut or lift, at A when dipper has reached its highest point, at B when ready to swing over car to be dumped.

foot of the boom; and a similar pair of engines geared directly to the dipper handle by means of a rack and pinion.

Steam is supplied in the smaller shovels by a straight flue vertical boiler, and in the larger sizes by a horizontal fire box boiler of the locomotive type. The usual pressure carried is 100 lbs., but some recent shovels have been designed for as high as 140 lbs. Water is carried in a steel tank placed either on the deck beside the boiler or suspended beneath the car between the trucks. Usually both pump and injector feed is supplied. Fuel, generally coal, is carried on a platform hung at the rear end of the machine.

The hoisting drum can be locked in any position by means of a brake band operated by the engineer's foot. The shovel is propelled by gearing and chains driven from the main hoisting engines.

The active crew of a steam shovel consists of an engineer, a cranesman and a fireman. In some cases the automatic or revolving shovel requires but one man, but usually even with those a fireman is needed.

These are assisted by from four to six laborers or "pit men" who attend to setting the jack screws, leveling the ground in front of the shovel, placing track and the like.

The working of a shovel may be briefly described as follows: The engineer stands on the front of the car and at one side, where he has a full view of the dipper and work, and where are conveniently grouped the levers controlling the hoisting engine throttle, the hoisting friction and brake lever, and the swinging throttle. The propelling levers are also placed at the side of his platform.

The cranesman stands on the small platform hung from the boom near its foot and operates the thrusting or boom engines and the dipper dump line. He also directs the pit men, except in cases where the work warrants a regular "pit boss."

In digging, the engineer starts the hoisting engines and throws in the hoisting friction, thus raising the dipper. The cranesman then forces the dipper into the bank sufficiently to cause it to fill, but not enough to stall the engines, or tip over the machine.

When filled, or when the dipper has been raised to its limit, as shown by "A," Fig. 3, the engineer stops the hoisting engines, sets the hoisting brake with his foot, and swings the boom and dipper over the car, wagon, or whatever is being loaded.

At the same time the cranesman draws the dipper into position "B" and when it is over the dumping point, releases the dipper door latch by means of his dump line, thus dropping the load. The engineer at once starts swinging the boom back to the digging point, and re-

leases the hoisting drum so that the dipper will fall to position "C." The dipper door closes and latches by its own weight. By a quick thrust of the boom engine, the cranesman forces the dipper to the ground, and the machine is ready for a second cut.

The operation sounds simple, but when it is taken into consideration that the two men must work absolutely in unison and go through the various operations at the rate of three or four times a minute, it will readily be understood how skillful they must become.

As a matter of fact, they are among the best paid of such workmen, the engineers receiving on an average from $140.00 to $150.00 per month, and the cranesmen $100.00 to $125.00.

The railroad shovel when working is run on short sections of track, usually about 6 ft. long. These are carried ahead of the machine and placed in position by the pitmen as often as the limit of the dipper reach requires.

The time occupied in placing the track, releasing the jack screws, "moving up" and resetting the screws, seldom occupies more than four or five minutes.

With the traction shovel, short lengths of heavy plank are used instead of the track sections, except where the ground is unusually hard, in which case the shovel may be run directly on the ground.

In making a through cut, such as for a railroad through a hill, a shovel will make an opening 18 to 20 feet wide each side of track.

Shovels are rated in size according to their weight and range from the small ones of fourteen tons, carrying a one-half cubic yard dipper, to the immense machines used for rock excavation and weighing ninety-five to one hundred tons, and equipped with a dipper holding five cubic yards.

They will handle a great amount of material, depending entirely, of course, upon its character. In ordinary earth, an average sized machine will move two thousand or more cubic yards per day.

At the St. Louis Exposition the Atlantic Equipment Company exhibited a new shovel which is a radical departure from anything built previous to that time. In this machine the hoisting engines, instead of being mounted on the body of the car, are placed directly on the swinging circle, and raise and lower the dipper by means of wire ropes passing around suitable drums and sheaves, instead of by the cable chain used on other makes.

The particular claims made for this construction are that the wire ropes reduce the friction losses to a very great extent, and by their peculiar fastening to the dipper, permit of a much greater clear

height under the dipper door with the same angle of boom. The placing of the hoisting engines on the swinging circle gives additional room on the car for the use of an extremely large boiler.

Up to about 1900 a shovel having a dipper capacity of 3 or 3½ cubic yards was considered the limit. But at that time the Wisconsin Central ordered one from the Marion Company and one from the Bucyrus Co., each having a dipper holding 5 cubic yards. These proved so very successful that many of that size have since been built.

Below is given, in tabular form, approximate general dimensions of a few of the various sized shovels:

WEIGHT AND SIZE	Capacity of Dipper Cubic Yard.	Length and Width of Car Frame.		Length of Boom.		Clear Ht. of Dump under dipper door.		Width of through cut at 8 ft. elevation.		Size Hoisting Engines.	Size Swinging Engines.	Size Boom Engines.	Size of Boiler.	Size of Car Body I-Beam Sills.	Size of Hoisting Chain.
		FT	IN	FT	IN	FT	IN	FT	IN	IN	IN	IN		IN	IN
24 ton	1¼	24 x 7	0 3	20	0	10	0	40	0	7 x10	5 x 6	5 x 6	48" x 8' 4" vert.	10	⅞
35 ton	1½	30 x 8	0 4	21	9	10	0	48	0	8 x10	5 x 6	5 x 6	54" x 8' 6" vert.	12	1
45 ton	1¾	32 x 9	6 6	22	6	12	0	50	0	9 x12	6 x 6	6 x 6	48" x 10' 8" loco.	15	1⅛
55 ton	2	35 x 9	6 9	22	6	14	0	50	0	10 x12	7 x 7	7 x 7	54" x 12' 4" loco.	15	1⅛
65 ton	2½	37 x 10	6 0	25	0	15	0	52	0	10 x14	7 x 8	7 x 8	54" x 13' 0" loco.	15	1¼
75 ton	3	39 x 10	6 0	30	0	17	0	54	0	12 x15	8 x 8	8 x 8	58" x 13' 0" loco.	20	1¼
85 ton	4	41 x 10	6 0	30	0	17	0	56	0	12 x16	8 x 10	8 x 10	60" x 13' 3" loco.	20	1⅜
95 ton	5	42 x 10	0 0	30	0	17	0	62	0	14 x16	9 x 9	9 x 9	66" x 14' 3" loco.	20	1½

While the shovels are generally operated by s ... ave been very effectively equipped with electric moto

Fig. 2—Railroad Steam Shovel digging shale rock near Marblehead, Ohio. Built by the Marion Steam Shovel Co.

compressed air. The latter is especially desirable when a shovel is used in tunnel work, as it not only prevents the fouling of the air, as would occur with coal, but the exhaust from the engines aids materially in the ventilation of the tunnel.

In the digging of the Gallitzen tunnel of the Pennsylvania Railroad, a steam shovel was successfully used by fitting it with a special short boom and dipper handle, the boiler being used simply as a reservoir to receive the air from a compressor plant located outside the tunnel. No other change was found necessary in the machine.

Electrically driven shovels are being used where water and fuel is scarce, as in the dry placer gold fields, and in places where the shovel is seldom moved long distances, as in clay and gravel pits. Electric railroads are using them to dig ballast, etc., the power being supplied from the regular trolley wire.

The completion of the Panama Canal is largely made possible by the use of steam shovels, there being at present sixty-one at work, and many more ordered. Those in use there now are divided into thirty-two 95 ton machines, with five yard dippers and twenty-eight seventy ton with three yard dippers.

There is also one small 45 ton shovel with 1¾ cubic yard dipper, that is easily transported from place to place, to take care of land slides and such work.

Besides their use as a shovel, the machines can be used as a most effective wrecking crane by dropping out the dipper and handle and using a hook on the end of the hoisting chain. It is a very frequent sight on a large contract to see a shovel being used to replace derailed cars and locomotives, or for lifting large rocks or timbers, which are chained to the dipper. One of the illustrations shows a large rock, weighing probably 6 or 8 tons, resting on the dipper.

New uses are constantly being found for steam shovels every year, as they are becoming better known. For instance, they are largely supplanting hand labor in the digging of large trunk sewers, etc. In this case, the shovel is generally taken off its wheels and mounted instead on a timber frame work spanning the trench being dug, and extending far enough on each side to prevent any possibility of the weight of the machine causing the sides to cave in. The entire affair is then carried on ordinary house rollers running on planks laid on the ground. An extra long dipper handle is substituted for the regular one and a special shaped dipper is generally used.

A shovel in Chicago used in this way and carrying a 1¼ cubic

yard dipper, dug a sewer trench twenty-two feet deep by eleven feet wide through stiff clay, moving ahead at the rate of 175 to 200 feet per day.

They are also being used in the ore ranges of Michigan and Minnesota, for stripping the overburden of earth from the ore deposits, often to the depth of seventy feet or more. This has proven to be cheaper and better than the regular underground system of mining.

Owing to the terrific strains to which a steam shovel is subjected, it has become a decided problem to secure the proper strength without making the size and weight of the whole machine over-run all practical limits.

The very best of material and construction must, of course, be used in every part, and to secure this the builders have been forced to equip their plants with means of producing practically every part direct from the raw material.

The larger ones now make their own steel as well as iron castings and their own boilers and chains. The latter are all hand made, and are the best produced anywhere.

Their forge shops are supplied with the heaviest of steam hammers for forging the large shafts, dipper teeth, A-frame legs, etc. They maintain fully equipped laboratories, where all material is subjected to a rigid test before being allowed to enter into the construction of the shovels.

A force of skilled engineers and draftsmen is kept constantly at work improving and strengthening the designs in every way possible, and adapting the shovels to new work as the demand requires.

The demand for steam shovels is so great that the plants are forced to run day and night, and some of them are turning out machines at the rate of one every working day, and have orders enough ahead to carry them until the last of this year at least.

The steam shovel is strictly an American product as practically no heavy machines of this kind are made outside of the United States. American built steam shovels are now working in Norway, Sweden, Russia, the diamond mines of South Africa, South America, Cuba, Canada and other countries.

A few shovels of the revolving type are built in England, where they are known as steam navvies, but they cannot begin to compare with those built in the United States in any way.

While it is impossible to give any reliable figures on the cost of handling material with a steam shovel, owing to the many different conditions under which they work, it may be interesting to note a few examples.

At Ironwood, Mich., a steam shovel loaded over 430,000 tons of iron ore in five years at a cost, including repairs, of 2.53 cents per ton.

A steam shovel in Pennsylvania equipped with a 2 yard dipper, dug hard clay at an average cost of 5.1 cents per yard, whereas the cost previous to its introduction had been 7.4 cents, with plows and scrapers, and 10 cents when plowed and loaded by hand.

On the Knoxville, LaFollette & Jellico Railway, a 65 ton, 2½ yard shovel averaged 2160 cubic yards of solid granite overlaid with earth, working 24 hours per day, at a cost of 2.7 cents per yard. This included the cost of shooting the granite.

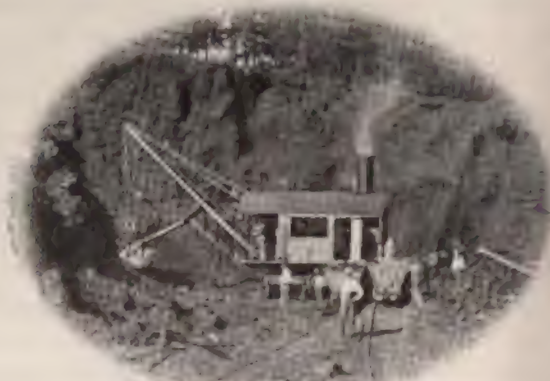
A small revolving shovel in Michigan averaged 350 yards of earth every ten hours, at a cost of 3.5 cents, replacing forty laborers and affecting a daily saving of $50.00.

Some of the leading manufacturers are the Marion Steam Shovel Co., the Bucyrus Co., the Atlantic Equipment Co., the Vulcan Iron Works Co., the Thew Automatic Shovel Co., the Toledo Foundry & Machine Co., and the Ohio Steam Shovel Co.

Since the above article was written, it has been brought to the writer's notice that the Osgood Co., of Albany, N. Y., built the second shovel in about 1850, and from the first used the boom type of design.

Also that the first so-called "all-steel" shovel was designed by Mr. H. F. Stock somewhere about 1880, and built by the Vulcan Iron Works Company for the firm of Stock & Wilcox. It was so much more powerful than the rest that it was nicknamed "Jumbo."

Acknowledgment is here due the various builders and Mr. A. W. Robinson, Montreal, Canada, for cuts and information furnished.



HANDLING MATERIALS BY BELT CONVEYORS.

BY W. D. BROWNING.

A GREAT many equipments for handling materials by means of belt conveyors are in use, and it is surprising the small amount of power needed and the durability of the system.

No doubt manufacturers of these systems have much to substantiate their claims for their designs, and that this method is a very economical means of handling materials.

Contractors are frequently confronted by the problem of removing large quantities of materials both from the excavation and to the point of erection of the building or other work in hand.

As this must be done in a very limited time, owing to the penalty clauses almost invariably inserted in contracts covering this class of work, and since it must be accomplished at least cost, it is necessary to use a more modern method than that of wheelbarrow or horse and wagon. Conveyor belts have been installed in many places and found to answer the purpose admirably, although as seen the usage is very severe, especially when handling rock and coal.

Anyone who has used ordinary rubber belts has probably found that the line of greatest wear is along the center of the belt.

Conveyor belts now on the market have a rubber cover, thickened at the center and the edges are stiffened, causing them to trough naturally, thereby following the lines of its supports without strain.

This stiffening is done by running two or three plies of duck a part of the way in from the edges.

The idlers on which the belt runs are an important part of a belt conveyor, so much so that some manufacturers refuse to sell their make of belt to run on some other style of idler.

Troughing idlers are made in many different forms, the pulleys being cast iron or pressed steel and mounted on hollow steel shafts supported by cast iron brackets.

Lubrication is accomplished by forcing grease into the shafts by compression cups, and through holes in the shafts the grease works into the bearings.

Belt conveying earth from excavation for gas tank of Mutual Gas Light Co., N.Y.

To prevent wet and sticky material from adhering to the conveyor belt, high speed rotary brushes with bristles of suitable fibre are located close to the belt at the discharge point and driven from the shaft of the discharge pulley. In the first illustration is seen a Robins Conveyor, used by F. M. Stillman & Co., of Jersey City, N. J., for carrying excavated material from the site of a gas tank of the Mutual Gas Light Co., at the foot of East 12th street, New York. This conveyor was 30 inches in width and 172 feet between centers. The material was delivered to the conveyor, through bridges spanning it, by wheeled scrapers which drew to it earth and rock from the area on either side. In this operation the wheeled scrapers received a full load, and crossing one bridge dumped it and again obtained a full load and discharged it through the second bridge before returning to the starting point. This gave a cycle of operation and a team traveled but a short distance to obtain a load. The earth and rock were discharged from the head end of the conveyor into scows tied up at the dock. As the work proceeded the conveyor was gradually lowered, without special regard to maintaining a regular slope, since the conveyor was successfully operated when out of vertical alignment. Tide water frequently covered the return belt, but in no way interfered with the working of the conveyor.

It has long been well known that there are few methods of exca-

vation as economical as wheel scrapers, and in connection with Robins Belt Conveyors they form a system which will excavate and dispose of earth and stone at a minimum cost per yard, and in the shortest time.

Another illustration is given of handling excavated material in the work for the foundations of the power house of the New York Gas and Electric Light, Heat and Power Co. The earth was delivered to the conveyor from wheel scrapers through bridges, and the excavating was done by practically the same means, employed more recently by F. M. Stillman & Co. for their work at East 12th street, New York, as mentioned above. The conveyor was driven at its head end by a small horizontal engine, very little power being required. It was subjected to the roughest kind of usage; rocks weighing over 100 pounds were constantly dumped upon it, but never caused a moment's

Teams and scrapers dumping earth on belt conveyors at the new plant of the New York Gas and Electric Light, Heat and Power Co.

stoppage during the entire work. The width of the belt was 30 inches, and the actual quantity removed exceeded 1,200 cubic yards per day. The work was all done during very cold weather, being commenced in December, 1899, and finished in January, 1900.

Perhaps no use of a conveyor is as severe on the belt as when carrying rock in broken form, and the next illustration shows a 24-inch conveyor 100 feet long supplied Chas. F. McCabe by the Robins Conveying Belt Co., for removing 10,000 cubic yards of earth and rock at 181st street and Jerome avenue, New York. The picture shows a very disadvantageous circumstance under which a Robins Belt

Handling broken rock with belt conveyor.

Conveyor will work to advantage. Earth was shoveled on to the conveyor by hand and was discharged from the head end to wagons. Pieces larger than a man's head were frequently placed on the conveyor, and were carried successfully, although it ran at times at an upward inclination of over 22 degrees. A Mundy engine, located in a pit beneath the tail end, drove the conveyor.

In the installation, illustrated and described in the foregoing, it was impossible to support the conveyor by any other than the most crude support. This fact, however, did not interfere with the successful operation of the conveyor, nor did it injure the machinery to any

appreciable extent. The belt itself, when the work was completed, showed little signs of wear.

Contractors also use the belt conveyor in carrying materials to and from the concrete machine when building foundations.

A writer in *Engineering-Construction* says: "Many of our readers will be astonished at the small amount of power required to handle a large amount of materials with belt conveyors. Since the cost of making concrete is largely the cost of conveying the materials to and from the concrete mixer, any data bearing upon this subject will be of great interest to all contractors having concrete work to perform. That the materials needed to make nearly 70 cubic yards of concrete per hour can be elevated 26 feet with a belt conveyor to the bins feeding the mixers and then conveyed away in the form of concrete on another belt conveyor with an expenditure of only 7 horsepower to operate the belts, is astonishing. Yet the facts are as stated."

After describing how such a plant is arranged, we shall give some data on the power required to run belt conveyors both when loaded and when empty.

While belt conveyors have been used on a number of concrete plants in New York and Philadelphia, the one used by the New York Contracting Co. in building the concrete walls for the huge gas works at Astoria, L. I., is especially interesting. The concrete mixing plant consists of two Smith mixers, each discharging its one cubic yard batch onto a short belt conveyor, shown in the illustration. This short conveyor delivers the concrete through a chute into dump cars, which take the concrete away to the forms. When concrete is conveyed on a belt it is apt to stick to the belt, so that a rotating cleansing brush is placed at the discharge end of the belt to keep it clean. This belt is 24 inches wide, 50 feet long, and travels 400 feet per minute.

Coming now to the belt used to convey the sand, gravel and cement to the mixers, we find the real labor-saving feature of this conveying plant. The sand and gravel are unloaded from scows by means of a clam-shell bucket operated by a derrick. The clam-shell unloaded into a small hopper from which the materials were fed into small dump cars and hauled away by a "dinkey," which ascends an inclined track onto a trestle. The sand and gravel are then dumped from the cars into bins under the trestle. The belt conveyor runs lengthwise of the trestle, under these bins, and the sand and gravel are fed onto the conveyor through gates in the bottoms of the bins.

The belt conveyor travels 105 feet horizontally under these bins,

then begins its ascent to the small bins that feed the concrete mixers. The belt rises 3.4 feet in 125 feet, and discharges sand and gravel into the bins above the mixers. The belt delivers sand for a little while to one bin, then it delivers gravel for a while to the adjoining bin, a deflector being used to direct the materials as they are discharged from the belt. Then the belt is used for a short time to convey bags of cement, so that all the materials are conveyed and elevated by this one belt.

It is especially worthy of note that after the sand and gravel are once unloaded from the scows, all the handling and conveying of the materials is done by power. Now as to the power required to operate the two belt conveyors.

The short 50-foot conveyor that carries the concrete away from the mixers requires only one horsepower to run it. The long 228-foot conveyor that carries the materials from the storage bins up to the bins that feed the mixers requires only six horsepower when delivering 100 tons of materials per hour. This long conveyor belt is 20 inches wide and travels at a speed of 350 feet per minute. To indicate the capacity of this plant we may add that the two Smith mixers have turned out 70 yards per hour, or 35 cubic yards per mixer per hour.

We began this article by saying that the amount of power required to operate belt conveyors is surprisingly small. We will add some further figures bearing upon this point. The belt conveyor plant above described was made and installed by the Robins Belt Conveying Co., New York City. Belt conveyors have been made by this company in large numbers for various purposes, not only in this country but in the mining districts of South Africa. A recent report of Government Mining Engineer of the Transvaal contains the following data relative to the power required to drive Robins belt conveyors:

At one mine a belt conveyor having a horizontal carry of 200 feet and a vertical lift of 48½ feet, delivered 71.4 short tons per hour with an expenditure of 8.1 horsepower, including loss of power in the electric motor used to drive the belt.

Another belt having a horizontal carry of 500 feet and a vertical rise of 25½ feet, delivered 90 tons per hour, with an expenditure of only 8.5 horsepower, including motor losses. A test on the belt when it was running unloaded showed that it took 2.9 horsepower to run the empty belt.

The Government Mining Engineer, speaking of the rapid growth of poularity of belt conveyors for handling ore, says:

Conveying bags of cement to concrete mixers.

Belt conveyor used to distribute material from mixer to bins.

"The chief reason for the popularity of belt conveyors is the saving of manual labor and attendance, but, in addition to this, the work is performed more economically than with methods previously in vogue, namely, gravity and tramway and elevator or rope haulage up an incline."

The illustrations in this article were secured through the kindness of the Robins Conveying Belt Co., Park Row, New York. Other articles on this system of handling materials will be given in this magazine from time to time.

SKIP OR BUCKET FOR EXCAVATING.

HANDLED BY TWO HOIST ROPES.

The skips, as shown in the photographs, are made in two sections, fastened together by a hinge at the top and by a latch at the ends near the bottom. These skips are placed upon flat cars in the tunnel and are loaded and run to the shaft on a narrow gauge track. The fall block of the hoister carries a steel I-beam, with a short chain and hooks placed in the ring at the apex of the ends of the bucket. While it is being hoisted, the skip is protectel from the sides of the shaft by means of a timber frame work, to which are fastened light T-rails as guides. After the car and skip reach the shaft the skip is hoisted to the surface and transferred by the traveler to the wagon in the street, where the hooks of the I-beam hanger are disengaged from the rings of the skip, and the load hauled to the dock for disposal upon the scow. At the dock, derricks are provided with an I-beam hanger and chains to lift the skips from the wagons. The derrick used for this work is provided with a double-drum electric hoist with a turning gear for moving the derrick boom. The only addition required to the derrick rigging when using this skip is a light wire rope attached to a hook on each side of the skip for the purpose of tripping the skip to discharge its load. These ropes connect above the fall block and fasten to the ring on the end of a single rope which runs over a sheave near the end of the boom, and from there passes over a

Skip placed on wagon to be taken to dock.

sheave near the foot of the mast, and from there to the hoister, where it is controlled by the hoister-runner. This rope is wrapped around a capstan head and over a sheave to which is attached a counter weight to take up the slack.

The novel feature of this skip is that, owing to the location of the supporting chains it remains closed without the use of the latches when raised by the derrick until the tripping rope is operated.

The weight of the skip holds the skip closed without the use of the latches. These latches are fastened in the tunnel before hoisting up the shaft, in order to guard against any accident that might occur by the skip striking the sides of the shaft, but are unhooked before the skip leaves the wagon to be emptied upon the scow.

After the hooks have been fastened to the skip, the skip is raised and carried above the scow and then lowered so that there will be no damage done to the deck of the scow by the [illegible]

hoister runner can empty the skip at desired height by checking the tripi ropes and lowering the fall block at end of the boom. The tripping ropes vent the two outer sides of the skip f falling, and the load then passes thro the opening between the two halve the skip.

The capacity of these skips is ali three cubic yards when loaded level the top.

Considerable time is saved over th method of using dump wagons ar dummy platform. These skips are ra from the wagon, dumped aboard scow and placed back upon the wago 30 seconds. From the time that a arrives at the dock to the time th leaves is only 1½ mins.; while it t from 2 to [illegible] minutes to unload a d wagon from a dumping board in sc[illegible]. Much time is also saved at [illegible] by eliminating the derrick, c [illegible] of the dump cars t the platform between the cages and st

Skip [illegible]

he contractors estimate that 25 per t more material can be removed in a responding time (with the elimination all noise in night work) by this hod than by others heretofore in use New York City.

Mr. George Perrine, C. E., of 22 William street, and Mr. D. L. Hough, M. Am. Soc. C. E., of 32 East Thirty-third street, New York, are the designers of this method of handling excavated materials. Patents have been applied for on the skip and its use. Illustrations from *Engineering, Contracting and Roadmaster and Foreman.*

NLOADING COAL FROM CARS WITH CLAM SHELL BUCKETS.

DICATING THAT BROKEN STONE CAN BE UNLOADED LIKEWISE WITH ECONOMY.

n an article in the February issue of magazine on the labor cost of a crete retaining wall at the Grand ntral Station, New York City, we suggted that a clam-shell bucket operated a locomotive crane could be profitably d in removing broken stone from flat s. In the work at the Grand Central tion, 40 per cent of the cost of mak- the concrete was charged to the cost shoveling and wheeling the broken ne Hence our suggestion that a m-shell bucket be substituted for d labor. Now, it is well known that w loads of broken stone are unloaded a small cost by means of clam-shell kets, but there seems to be considere doubt among contractors as to ether the shallow and narrow piles of ne in cars can be profitably removed the same manner.

With a view to throwing light on this tter, we have secured some valuable a on the unloading of coal cars with m-shell buckets.

At the Navy Yard at Washington, D. a locomotive crane, fitted with a 50- boom and a 1½-cu. yd. Hayward m-shell bucket has been in use for unloading coal from cars. A description of the crane is as follows: Track gage, 4 ft. 8½ in.; wheel base, 8 ft.; greatest width, 9 ft. 10 in.; maximum working radius, 30 ft.; hoisting speed per minute, 250 ft.; rotating speed, three revolutions per minute; traveling speed, 350 ft. per minute; capacity, one trip per minute. The machine will lift 20,000 lbs. at a 12-ft. radius, and 7,500 lbs. at a 30-ft. radius. The engine is a 9 x 12-in., double cylinder, double drum engine, fitted with the necessary clutches and brakes for controlling the swinging and propelling movements of the machine. The crane was manufactured by the McMyler Mfg. Co., of Cleveland, O.

According to data furnished by Mr. F. E. Beatty, commandant of the Washington Navy Yard, the machine will unload approximately 400 tons of coal in eight hours. The crane used in loading coal cars from the coal bin will dip and load 48 tons in 20 minutes. In unloading a car, the bucket easily takes out three-fourths of the contents of the car. The remainder of the coal is taken into the boiler house by opening bottom run to bunkers with a chute, and thus requires

no rehandling. In unloading the coal, one car is ahead of the crane, and the other behind, on the same track. The bucket takes a load, and, without stopping the swing of the boom, the coal is dropped; then the second car is reached, and the bucket filled. Commander Beatty considers that this makes not only less work for the man handling the levers, but also increases the output by 10 to 15 per cent.

A clam-shell bucket is also used at the Polk street plant, Chicago, of the Western Electric Co., in handling coal from cars to storage bin. In this case, however, the bucket is operated by an electric overhead traveling crane. This machine was built by the Whiting Foundry & Equipment Co., of Harvey, Ill., for the Western Electric Co. It is of the three-motor type, and has a working load capacity of 10,000 lbs. The span, center and center of runway rails is 73 ft. 10 in. The lift (maximum vertical travel of hook) of the main hoist is 37 ft. The crane was designed to operate at the following approximate speed, the speeds being given in feet per minute:

	With maximum rated load.	H. P., required.	Speed without load.
Main Hoist ...	50	25	100
Bridge Travel.	250	25	310
Trolley Travel.	100	3¼	125

Each motion of the crane is operated by one independent motor especially designed for crane service. Each motor is provided with one improved controller located in the cab. These controllers allow a wide range of variable speeds for respective movements, when working in either direction. Each motor controller is governed by a single handle which will start the motor in one direction when moved one way, and will operate it in the opposite direction when moved t way from the central position They are capable of controlling tl of the motor with any load and h ficient resistance to permit the starting of the lightest load. A : speeds is given of from 2 feet pe: to full speed for hoisting and prc ately for other movements.

The average travel of the ‹ about 50 feet. A 2-cubic yard I bucket is used.

Mr. G. A. Pennod, Factory E for the General Electric Co., st: a 40-ton car of coal can be unl‹ from 1½ to 2 hours, depending travel of the crane for deposi coal. From five to six cars a da ing for switching, etc., can be ι in a day. It takes two men to ι car; one man to operate the cr: one man to shovel what coal re the corners of the car which the on account of its bulky nature, pick up.

This last operation takes a much time as unloading with th alone, that is, the bulk of the c 40-ton car can be unloaded in a minutes, and it takes the same of time for one man to shovel o remains. The time of this last tion can, of course, be reduced ting on more men.

If we assume that a man sho at the rate of 4 tons per hour, i dent that the clam-shell bucket all the coal in a car except abou which must be shoveled out by

It is apparent from the two fc examples that a contractor need afraid that a clam-shell bucket clean up a carload of broken st ficiently well for practical purpo

—*Engineering-Contra*

GENERAL NEWS.

st and Carrying Machine.

ine is the result of years of y to provide a ready means carrying and lowing heavy are ordinarily transported by means of hand trucks locks. It is adapted to be es, bales, heavy freight, &c., ne of travel is practically a

ine was originally designed ted to hoist and carry crates nning factories to and from its use in this important field very popular machine.

le clutch on the shaft oper- vel the heaviest load which the machine is capable of handling can be raised or lowered, and by the movement of a second lever the load can be carried out or in on the track as desired. The track, as shown, is suspended from the ceiling, and the trolley is made up of four wheels as in the ordinary type.

This machine is the product of C. S. Harris & Co., Rome, N. Y.

Echoes of Foundrymen's Convention.

A prominent feature of the convention of American Foundrymen's Association, at Cleveland, June 3-7, was the many exhibits placed there by many manufacturers to illustrate their product.

Among these was that of the Electric

The Harris Hoist in a warehouse.

Controller & Supply Co., of Cleveland, who had on display a complete line of Dinkey ventilated and type "U" controllers, electric brakes, arc welders, and a working exhibit of a lifting magnet handling pig iron.

For werk in and about a foundry, no apparatus is so useful as a crane equipped with a lifting magnet.

As shown in the illustration, the magnet was operated by an electric hoist to demonstrate its lifting and holding power.

A number of well-known Chis[illegible] Moore Co.'s hoists and trolley[illegible] shown in an exhibit which was a[illegible] to permit actual operation of th[illegible] of machinery.

All of the foundry supply hou[illegible] represented.

The Buckeye Milling Co. had [illegible] land Dry Core Compound and [illegible] Core Binder.

The J. D. Smith Foundry Sup[illegible] Cleveland, had drawings for a [illegible]

Lifting magnet shown at Foundrymen's Convention by Electric Controller & Supply Co., C[illegible]

foundry and a full assortment of foundry supplies, especially a moulding machine attached to a post and made adjustable to varying work.

The Atlas Car Mfg. Co., Cleveland, were represented with a lot of industrial cars and tracks.

The Standard Sand & Machine Co., Cleveland, had in operation various machines for preparing sand in a foundry.

The exhibits that used power were supplied by a 55 h.p. gas engine installed by the Bruce-Merriam-Abbott Co., of Cleveland, who build gas engines from 1 to 100 h.p.

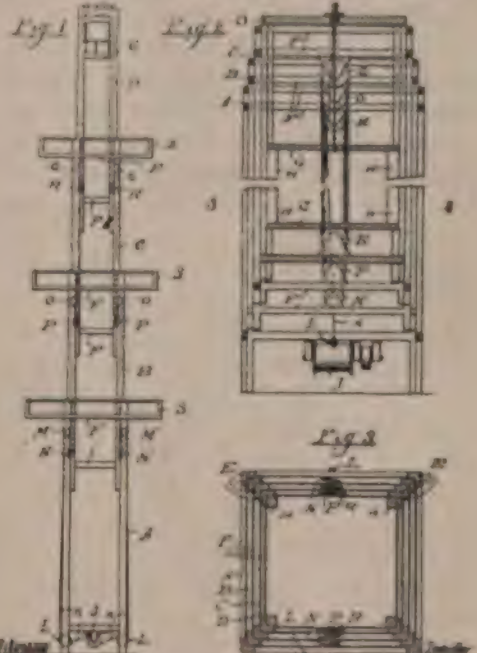
One feature could well have been omitted, if the report is true, the supplying of beer, free, through a large cupola. Pipes were laid, and a constant stream flowed from the tap hole to all who cared to partake with souvenir steins. And so this convention passed into history.

Recent Inventions.

Specially reported for Browning's Magazine by C. LeRoy Parker, Solicitor of Patents, 639 F. St. N. W., Washington, D. C., to whom all correspondence with reference to this matter should be addressed.

TELESCOPIC ELEVATOR.

This elevator, recently patented by Janko Kovacevic, consists of a number of substantially rectangular frames A, B, C and D, preferably constructed of steel and each of which comprises four corner-posts consisting of heavy angle irons E, which are connected by means of suitable cross-bars and braces F, the angle irons E of said members B, C and D fitting within each other and forming guides for each other, said frames being longitudinally movable relatively to each other. Within the innermost member D is a longitudinally-movable car G, the corner-posts H for which are movable in the corners of the frame D. Mounted in the lower end portions of the said frame A is a windlass J, over which cables K are adapted to be wound, said cables being connected at their other ends to the upper rim of said car G and trained over a series of pulleys L, M, N, O, P, Q and R, said pulleys L being mounted upon the lower end portion of said member A, the pulleys M on the upper end portion thereof, the pulleys N on the lower end portion of the member B, the pulleys O on the upper end portion of said member



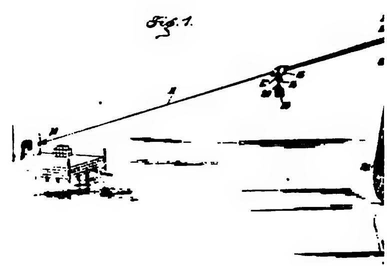
B, and so on, the said pulleys being so set that the said cables in passing over one to the other thereof are maintained in a vertical line as nearly as possible, so as to prevent them from running off said pulleys. By turning said windlass to wind said cables on same the said car G will first be raised to the upper end of said frame D and before reaching the upper limit of its movement, which will be determined by suitable stops on said member D, the said cables will raise said member D and successively thereafter the

members C and B until each of same has reached the upper limit of its movement. The number of said members or frames A, B, C, and D may be increased or diminished as desired to attain any desirable elevation, as will be obvious.

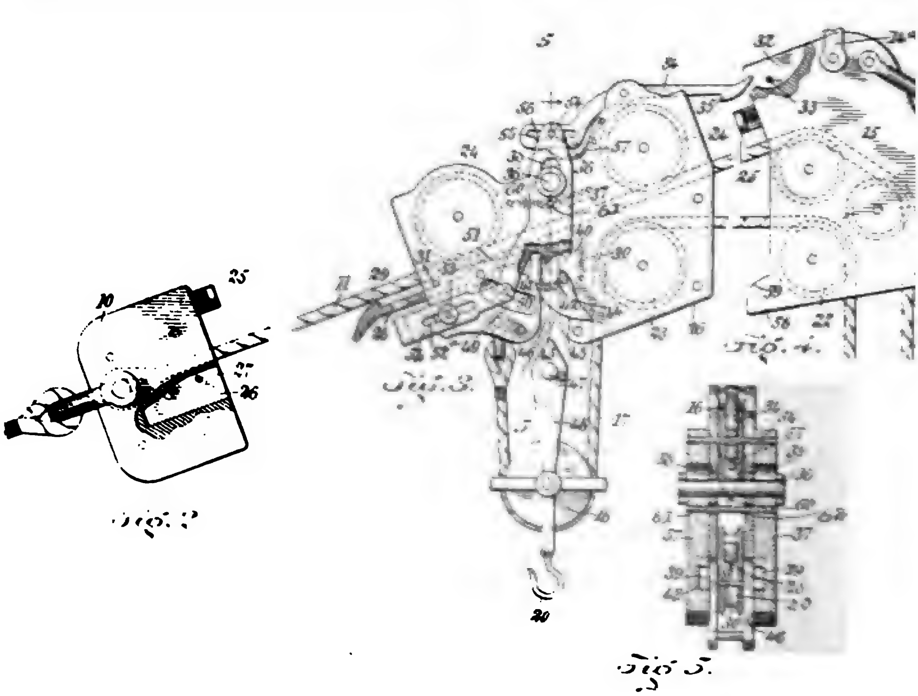
HOISTING AND CONVEYING APPARATUS.

This hoisting and conveying apparatus recently patented by Charles J. Horgen, New York, N. Y., is especially designed for loading and unloading ships.

The operation of the device is as follows: Assuming the stud 47 to be in the channel 39 and resting on the surface 42, and that the cable 17 is being let out, so that the carriage slides down the inclined cable 11, it will be seen that when the carriage engages the buffer 25 the end of the bar 52 will engage the outer surface of the block 10. This pushes the bar rearwardly with respect to the carriage and swings the arms 37 about the shaft 36, so that the surface 42 will move out of the way of the stud 42. This removes the support of the latter and it drops out. The weight of the pu now causes it to descend, taking the cable 17, which is being paid the other end under control of the The descent of the pulley to the place will be readily understood. obvious manner the catch 29 enga pin 27 when the carriage reaches sition described above, and also w bar 52 is pushed inwardly the pin



gages the left-hand slot 56. Thi the arms 37 in the position in whi were forced by the bar 51. As th 37 are normally held in an elevate

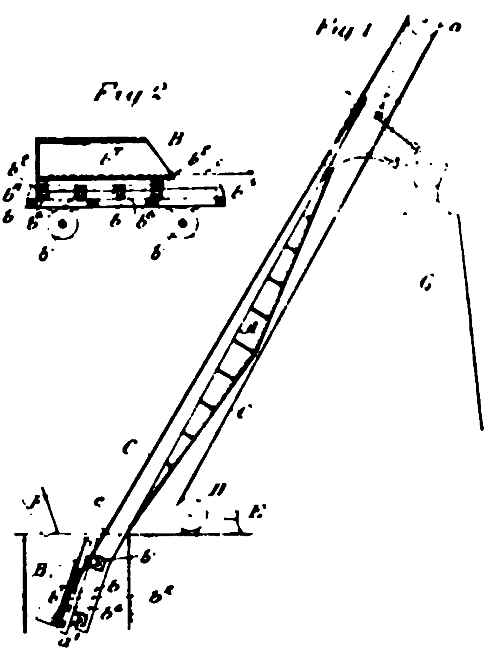


tion by springs 60, the ascent of the pulley 18 when the hoisting-engine is operated to raise it will cause the studs 47 to slide up the cam-surface 45 and engage the cam-surface 41, which at that time is in registration with the slot 46. Further force applied by the hoisting-engine will operate to cause the studs to engage the bar 28, which is located behind the slot 40, and disengage the catch 29 from the pin 27. This allows the carriage to move upwardly along the cable, and when this operation commences the studs 47 will settle back onto the cam-surface 42, and this will pull the arms 37 into their lowermost position, bringing them also back to central position, with the pin 54 between the two slots 56. When the carriage reaches the block 12, the catch 35 is at first in such a position that it cannot engage the pin 33 on account of the weight on the arms 37; but the continued operation of pulling on the cable 17 forces the studs 47 to rise against the cam-surface 40 and then to drop along the cam-surface 44 and force the arms to the rear, so that the pin 54 will engage the right-hand depression 56 and the pulley will slide off from its support. The engine is stopped at this time and the weight lowered to the deck by the ordinary means, it being controlled as usual, by a brake or the like. Before this occurs the carriage is forced up the incline 50, so that it is left in a position with its front lower surface on the inclined surface 50, and as soon as the weight is removed from the surface 42 the spring 57 is free to act to force the catch into engagement with the pin 33, so as to lock the carriage to the block. In raising the load and pulley to the block again the first operation is to cause the studs 47 to engage the surface 41 and drop back against the surface 42 when the strain on the cable caused by the hoisting-engine is removed. As the carriage is held up by the surface 59 until this time, it will be seen that the weight of the pulley and load thereon will free the catch 35 from the pin 33 and allow the carriage to slide down this incline and then run down the inclined cable. From this point the operations above described can be repeated.

HOIST.

The accompanying illustration shows a hoist invented by G. W. Bollman, of Pittsburg, Pa., and assigned to the Otis Elevator Co.

The construction of the hoist will be obvious from the illustration. When the engine or motor is started the only load upon it will be the weight of the bucket, frame and the contents of the bucket and



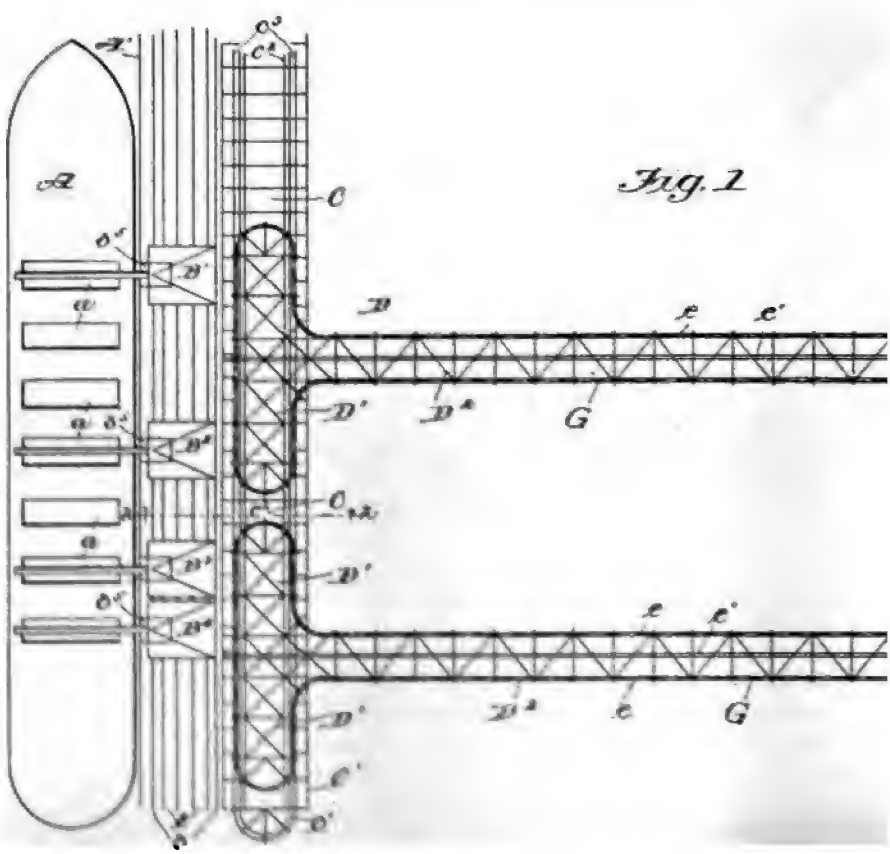
that by reason of the movement of the load relatively to the body of the car the engine or motor is enabled to acquire momentum before it starts to raise the load and car together. The advantage of the invention in the case of two-cylinder en-

gines can be readily understood. For starting this type of engine only one cylinder is available, and the only load upon it will be the bucket, frame and contents of the bucket. The movement of the load independently of the body permits of both pistons being brought into service before the full weight of the bucket, frame, contents, and body b is to be raised on the incline. It will be understood that after the frame b2 has been moved against the stop b5 of the body of the car, as shown in dotted lines, the continued action of the engine or motor wll raise both to the top of the incline where the contents of the bucket may be discharged into the furnace G.

OPERATING MECHANISM FOR CLAM-SHELL BUCKETS.

This invention relates to an operating mechanism for clam-shell bu(object of the invention being t improved trolley construct: mounting whereby the operato carried by the trolley and the e1 ing, elevating, and other mov(the bucket is entirely under tl of the operator in the trolley-c

In operation the bucket 15 and hoisted on the hoisting-c As soon as it is closed, howev(hoisting it is necessary to star chinery in motion, which hois hold-ropes 22 to prevent acc1 of slack in these ropes. When t is hoisted and conveyed and dump, it is necessary to set bra the spools or drums carrying cables 22 and slack off on t cables. This throws the weig bucket on the hold-ropes and t



opens by gravity. In this arrangement the hold-cables 22 are wound in and unwound from spools 20, running loose on the same shafts as the hoist-spools 16 and 19 on the trolley. They are actuated by a suitable clutch thrown by the operator. This clutch connects the hold-rope spools together, and they turn in the same direc-

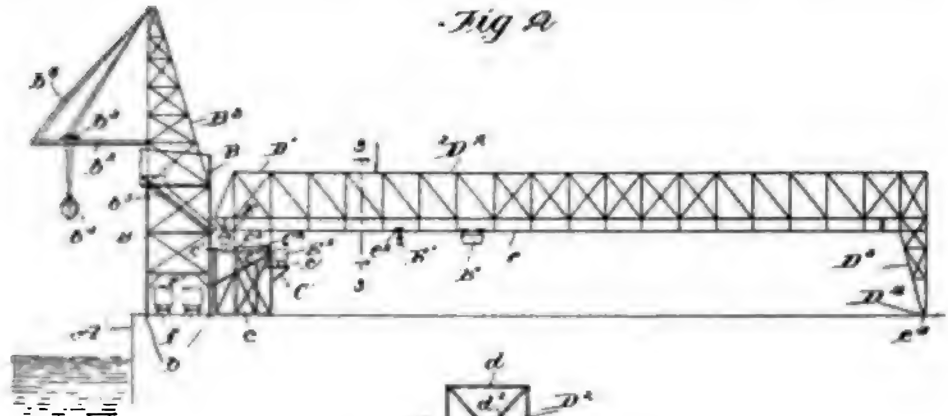


Fig 2

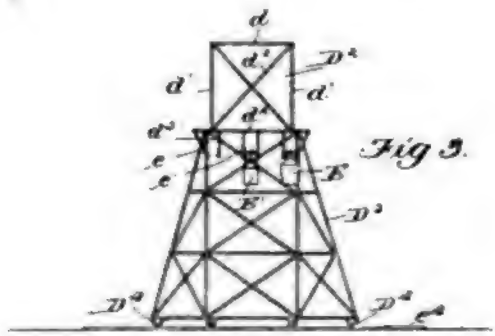


Fig 3.

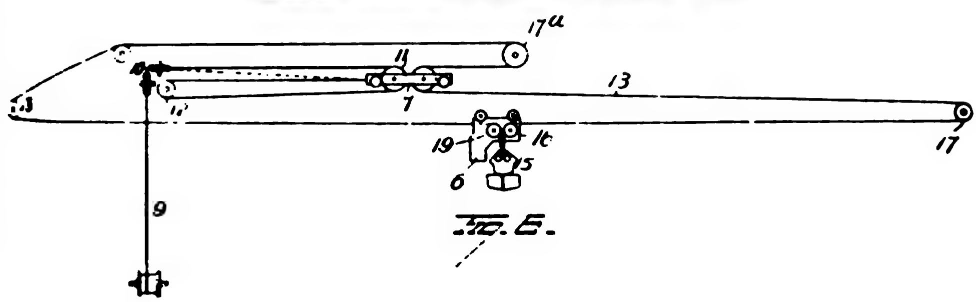
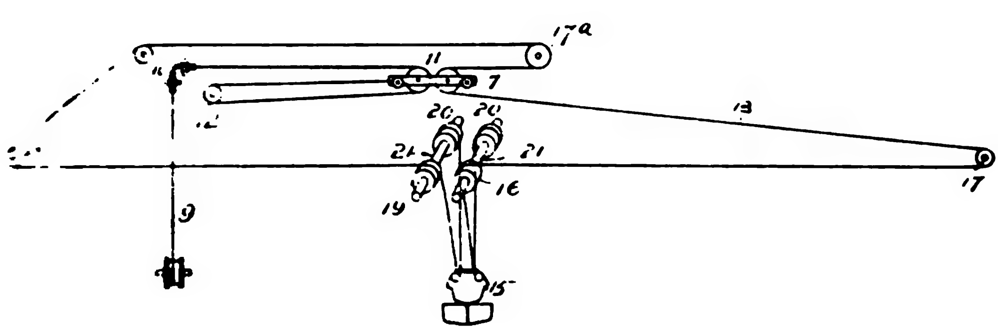


Fig. 6.

Fig. 7.



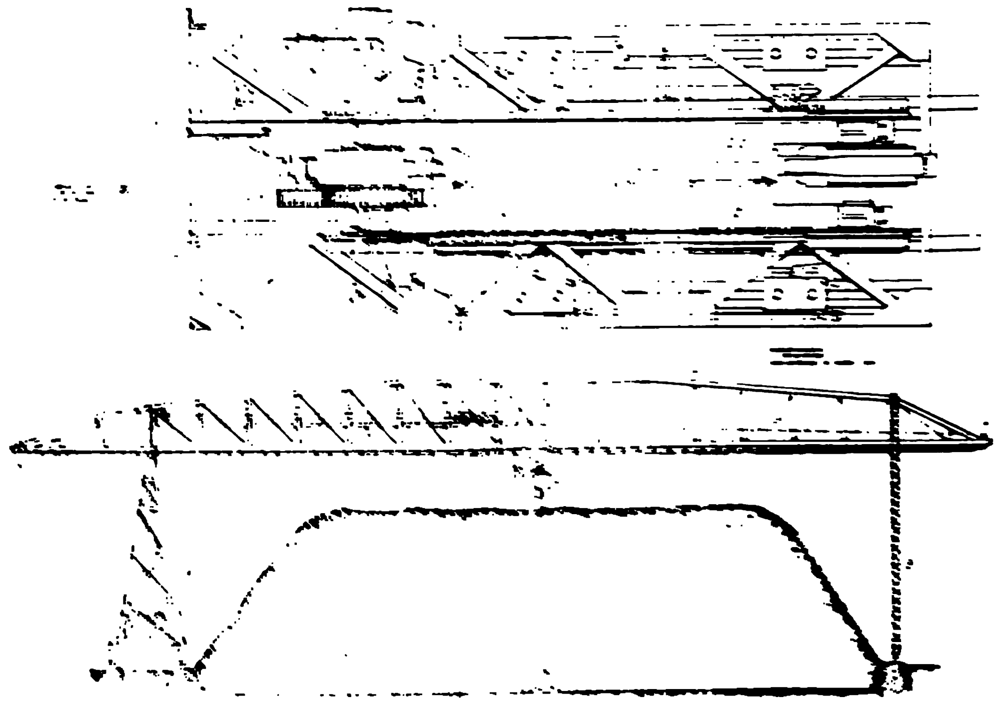
tion with the same speed, due to the friction of the hoist-cables around the hoist-spool. Located on the trolley 6 and connected by gear-wheels 24, 25, 26 and 27 with one set of track-wheels of the trolley is a motor 28 for imparting travel to the trolley, suitable brakes 29 being provided, as shown, for stopping and locking the trolley at any point of its travel. The trolley is provided with a cage 30 for the operator, and this cage has installed therein the necessary controller for the motor and the levers for actuating the clutches on the hold sheaves or spools and the necessary levers for the brakes of the track-wheels and hold sheaves or spools. As the operator in the cage controls all the movements of the trolley, it is of course essential that the motor in the tower 2 which actuated the hoist-cable 13 be also under his control, and this can be accomplished by trolley-wires running through the bridge and electric pick-ups attached to the carriage and connected to a controller placed in the operator's cage on the trolley.

This invention has recently been patented to F. E. Hulett, of Cleveland, and assigned by him to the Wellman-Seaver-Morgan Co.

APPARATUS FOR UNLOADING, STORING AND RELOADING MATERIAL.

The accompanying illustration shows an invention recently patented by W. J. Selleck, of Riverside, Conn.

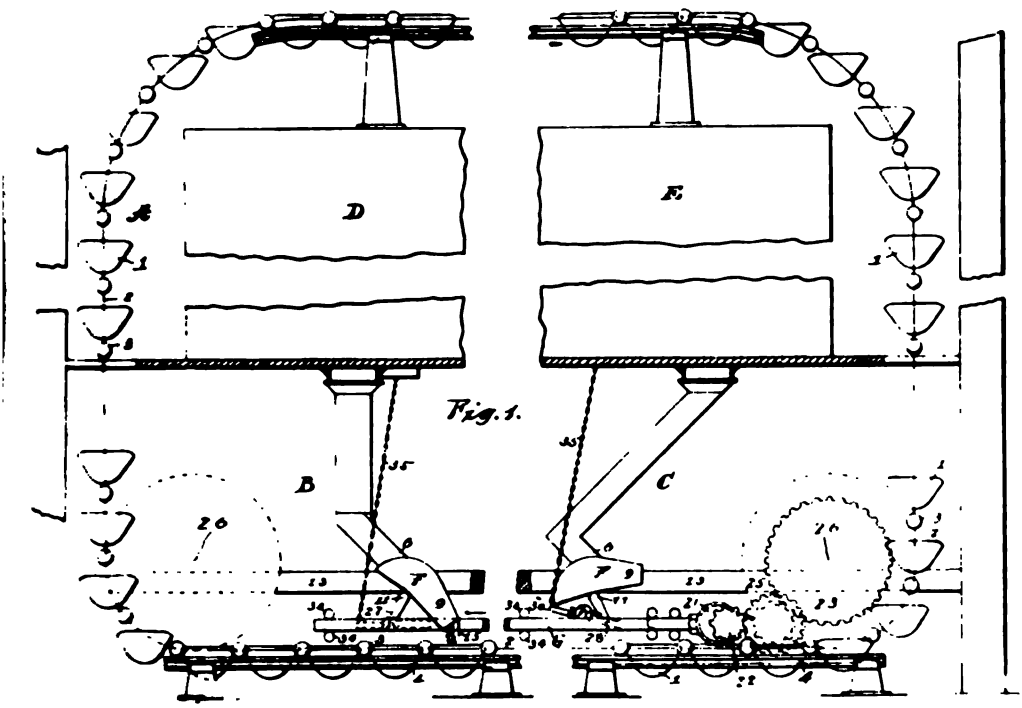
At points where coal is unloaded, particularly from vessels, it is desirable that facilities should be provided either for immediately reloading the coal upon cars or for storing it in pockets preparatory to reshipment or for storing it throughout a storage area from which it may be removed and reloaded upon cars, as occasion requires. It is the object of this invention to provide an apparatus for unloading coal from anyone of several points or simultaneously from a plurality of points—as, for instance, the hatches of a vessel—and transferring the coal either



to any one of a series of pockets or to any desired point in a storage area from which it may be removed and reshipped.

This invention, generally stated, comprises one or more portable towers for removing the coal from the hatches of vessels, a traveling crane projecting above storage-pockets and extending over a storage area, conveying means supported upon the crane for receiving the coal and transporting the same to points above the storage area, and conveying devices also supported from the crane for removing the coal from the storage area and depositing the same in the pockets preparatory to reloading upon cars.

The operation of the device is as follows: The towers B8, etc., are moved along the track by any suitable means to points opposite the hatches of a vessel A. The width of the towers is such as to permit them to be located opposite adjacent hatches. The cranes D are then propelled by any suitable motive means to points opposite the towers. The buckets b4 are then operated to remove the coal or other material through the hatches of the vessel and dump the same above the chutes b5 of the towers. The coal passes through the chutes either directly into the pockets C and thence into cars F, or it may be received by the cars E2, which are supported upon the track c' above the pockets C and beneath the discharging ends of the chutes and conveyed by such



Willson Conveyor Chute.

cars to points above the various chutes in the series remote from the point where the coal is being unloaded, thereby enabling all of the pockets in the series to be filled with coal conveyed to them from the point where the vessel is being unloaded. The return portion of the tracks c' is supported at a lower level, so that the empty cars will pass beneath the paths of movement of the cars E and pick-up E'. The coal passing from the chutes b5 may also be received by the

cars E, depending from the endless track e, and conveyed by them to points above the storage space between the opposite ends of the travelling cranes and dumped. When it is desired to remove the coal from the storage space, the pick-ups E' are operated, which convey the coal from the storage area to points above the pockets, where they are dumped, thereby depositing the coal in the pockets ready for reshipment.

[illegible]

overcome this, the Yale & Towne Mfg. Co., of New York, have supplied a special swivelling top hook with collector rings and ball bearings as shown in the attached illustration.

The terminals pass into the top hook down through the shank of the hook and thence to the insulated collector rings.

[illegible] contact with [illegible] to the [illegible] leads in [illegible] This [illegible] swivel [illegible] without [illegible] flexible [illegible] enables the [illegible] much [illegible] equipment is [illegible] means of a [illegible] enabling [illegible] large [illegible]

Pipe Forcing Jack.

For forcing or pulling pipe horizon-y underground where trenches could well be made is the duty of Bassett e Forcing Jack.

This jack consists of a cage, which vels on a rack, being moved by a ket lever and pawls.

At the front of the cage is a groove l clamp for holding pipe ¼" to 4" in meter.

A whole length of pipe of sizes up to ", with a pilot, is forced the length of e rack. The cage is then released and temporary piece 7' 4" long is used and e pipe forced forward. A 14' 6" piece then used, and after forcing forward full length, permanent section is sub-tuted.

The pipe is given a rotary motion by ans of a pair of tongs while it is being ced. Two-inch pipe is easily forced listance of 60', the pilot being a piece 2½" pipe 18" long.

The jack is made by the Duff Mfg. ., Pittsburg, Pa.

News Notes.

Consular Agent Carleton, of Almeria, tes that the Alquife Mines & Ry. Co., ., one of the largest iron ore companies southern Spain, has begun converting fine hematite iron ore into briquettes.

The primitive and inefficient manner in which the graphite deposits of Ceylon are worked under native management has attracted the notice of outside mining engineers. It is stated that a concerted attempt is being made to work some of the plumbago mines on a scientific basis, with the anticipated result that the existing output will be largely increased.

The Standard Oil Co. has ordered two "Hornsby-Akroyd" oil engines of 25 H. P. each, which will be shipped to Chinkiang, China, and used for pumping purposes. These engines are supplied by the De La Vergne Machine Co., of New York, who state that the use of oil engines has increased enormously in the past few years, there being now over 14,000 oil engines of the "Hornsby-Akroyd" make alone in operation.

Actual operation in the construction of the new Belt Line Railroad, which is to encircle Cleveland, started June 13th. This enormous undertaking will be completed within three years. The first ten miles was sublet to Connell Bros. by John Marsch, Green Bay, Wis., and must be completed by May 1st, 1907. When everything is in full swing, more than a thousand men, 200 horses and several large steam shovels will be at work. Progress of this line will be noted in these columns every issue, using photographs.

INDUSTRIAL NOTES.

The ship yards of Nagasaki, Japan, employ 7,000 workmen all the year round.

The Allis-Chalmers Co. San Francisco office is now located at 906 Broadway, Oakland, Cal.

The Power & Mining Machinery Co., Cudahy, Wis., has included two new cranes in their recent improvement.

Champion Blower & Forge Co., Lancaster, Pa., has recently installed several cranes in their new foundry building.

The A.,T. & S.F. Ry., San Francisco, Cal., has authorized the construction of a large electric crane for the San Francisco Terminal.

The plant of the H. K. Porter Co., Pittsburgh, is to be moved to Economy, Pa., where the company has secured a tract of 40 acres.

The Seattle Car Co., Seattle, Wash., has increased its capitalization to $100,000, and will begin the construction of a new plant within the next sixty days.

The McClintic-Marshall Construction Co., Pittsburg, Pa., has been awarded a contract for the steel work for a 2155 ft. steel viaduct to be built over New River, near Glen Lind.

Municipal Engineering & Contracting Co., Chicago, has recently built a new automatic charging concrete mixer designed especially for street work. It is self-propelling and will scrape concrete the entire width of a 50 ft. street.

The Daily Telegraph (London) states that the government has decided to abandon building one of the two war ships of the Dreadnaught class, planned for the current year, and thus effect a saving of nearly $10,000,000 in ship building.

The Stroudsburg Engine Works, Stroudsburg, Pa., announces the organization of their company with an increased capital stock. Preparation is now being made for increased output and capacity, and the trade will find deliveries prompt under the present management.

The Bucyrus Co., So. Milwaukee, Wis., is building 63 steam shovels, 3 railway cranes and one railroad pile driver for work at Panama. This comprises all the steam shovels, railway cranes and railroad pile drivers purchased by the Isthmian Canal Commission to this date. (April 20th.)

Peacock's Iron Works, Selma, Ala., state that they have orders for 50 cars from the phosphate mines in Tennessee, and 50 cars for sugar cane plantations in Louisiana, and dozens of small orders from all sections of the country. This concern makes a specialty of steel trucks, car wheels and cars of all sizes and kinds.

The Jeffrey Mfg. Co., Columbus, O., have issued a leaflet with many illustrations describing one of their coal handling equipments for wholesale and retail yards. This consists of a 750 ton wooden storage pocket, a run-around combined elevator and conveyor, driving machinery, loading chutes and power shovel for scraping coal from box cars into loading hopper.

ENGINEERING DEPARTMENT

INCLUDING

DRAFTING ROOM PRACTICE.

RULES OF PRACTICE.

Mechanical drawing is full of conventionalities; and two drawings of the same piece made under different rules of practice would differ so that they would be confusing to the machinist to whom the drawing was sent and for whom it was made. To avoid this confusion and at the same time to keep a standard from which the draftsman can work, Rules of Practice have been adopted in most drafting rooms.

The following are submitted not because they are considered ideal—even though that name is substituted for the shop in which these are used—but to induce others to discuss these and submit other rules that they may consider superior.

Every shop should have its Rules of Practice and I sincerely hope that many may criticise and submit rules for those they do not like.

RULES OF PRACTICE—Drafting Room.

IDEAL MACHINE CO., IDEALTON, N. Y.

Lines

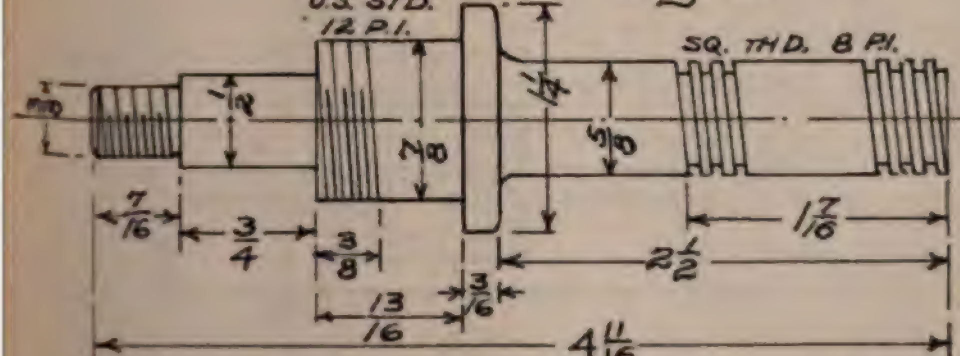
Object lines, visible and invisible, are to be in black ink and the same width. Center, witness and dimension lines to be in red ink.

Center lines this: ——·——·——·——

Witness lines thus: —— —— —— ——

Dimension lines thus: ←—— $1\frac{7}{8}$ ——→

Fig. 1.



ADJUSTING SCREW. — 1 — M.S.

Selection of Views

Select the number of views necsesary to illustrate the object, no more, no less. When a note will save the drawing of an extra view do not hesitate to insert it. Use dotted lines sparingly. using section views in preference.

One view is sufficient when showing circular pieces, and, when interior details are to be shown, make that view a section.

Scale and Size of Sheet

Choose the largest possible scale and the smallest size sheet consistent with good work.

Castings and Forgings

Make drawings of castings and forgings on different sheets. Castings, upon which very little machine work is to be done, may be drawn at a reduced scale. Forgings should be drawn full size if possible

Title on Details

Each detail should have its name, the number used on one machine and the material from which it is made printed in letters ⅛ inch high below the drawing. See Figs. 1 and 2.

Abbreviations for Metals

When placing the title under the detail drawings, use the following abbreviations for different metals:

C. I.—Cast Iron. — M. I.—Malleable Iron.
W. I.—Wrought Iron. — S. C.—Steel Casting.
[illegible] — Br.—Brass.
[illegible]

[illegible]

Finish

[illegible] black f. The cross of [illegible] surface to be finished. [illegible]

[illegible] "finish all over" in black [illegible]

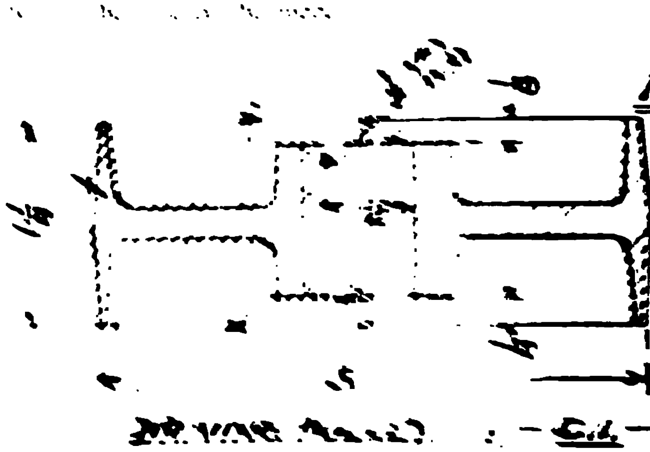


Fig. 2.

Screw Threads

Use the conventional method for representing screw threads, except in the case of square threads. Except in the case of V threads always give character of thread. See Fig. 1.

When other than standard threads are used, the threads per inch should be given thus: 16 P. I. When a thread is left hand, always call attention to the fact by note.

Notes

When notes are used in connection with the drawing, join the note and the part to which it refers by a wavy black line with an arrow head at the drawing extremity.

Section Lines

Make section lines as shown in Fig. 2, making dis-between lines in proportion to the area sectioned.

Bolt Lists

For standard bolts, nuts, set screws, machine screws, split pins, taper pins, etc., do not make detail drawings, but use bolt list.

Dimensions

Make figures to read from the bottom and right of the drawing as you face it. Place them, if possible, so they can be erased without touching a line of the drawing. When a dimension comes in a sectioned area, break the section lines as in Fig. 3.

On castings, give simply machinist's dimensions, not patternmaker's.

Give dimensions over all as well as sub-dimensions. Stagger sub-dimension lines as shown in Fig. 1.

Give radial dimensions as shown in Fig. 3. Use arrow head at one end and denote center by O.

For all dimensions up to and including 24 inches, give dimensions in inches; above 24 inches, in feet and inches. When all dimensions are in inches, the inch marks may be omitted. When dimensions are in feet and inches, use the feet and inch marks and divide them by a dash, thus: 3'—5¼".

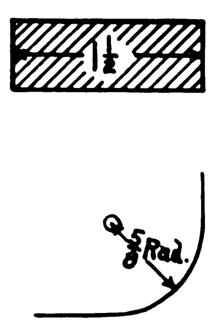


Fig. 3.

Give dimensions to center lines and finished surfaces.

Keep dimensions on one view if possible, but figure to full in preference to dotted lines. Do not repeat dimensions.

When giving angular dimensions, give the degrees to which the planer head will have to be set to do the work. Use the abbreviation deg. instead of the degree mark.

Thought

Think of the men who are to use the drawing and make it for *them*.

Keep in mind the machines used in manufacturing the several parts; this will in a measure determine your dimensions.

The Designer in the Small Shop.

TIBBAB.

How often do we find the designer in the large shop criticising most severely the design of some tool or machine which is the product of a smaller shop. This criticism of the design is of course a reflection upon the designer, and in many cases the criticism is most unjust.

My attention was called to this most forcibly the other day, when a man, in looking at a special machine built in a small shop, was heard to remark, "Why did he not cast those brackets on the bed instead of bolting them on?" There was no question in the minds of those present but what the change was desirable, yet I happened to know that an addition of four or five inches on each side of the bed would have been about two inches too much each side to have passed between the uprights of the largest planer operated by the company that built the machine.

The large shop, equipped with all appliances for machining and handling material and with a variety of machines upon which work may be done, does not hinder the designer in his work as does the small shop with its limited equipment. In the large shop the designer has to work simply for the best design, while his brother in the small shop is forced by the equipment to lay aside something that is best for something within the scope of the shop. Thus it is that the man of the small shop meets problems little dreamed of by the designer in the large shop and is forced many times to use not a little ingenuity to solve these problems. Under these circumstances the designer in the small shop is entitled to a great deal of credit for working up his design, and should not be criticised too severely by the man who is sometimes considered better because employed in a larger shop

The best designer, from a mech or economic standpoint, is he who his design to the machines and making up the equipment of his sl

By masterfully working out c whereby the small shop with its l equipment may profitably turn out apparently beyond its capacity, the man shows the distinguishing ch eristic of the *good* designer.

Approximate Patterns for Elbo

DON REX.

How many of us will not use ap mate methods for doing work when lute accuracy does not demand the retical method? Those who do n working at a disadvantage and spe more time than is necessary, conse ly are expensive men, no matter their salary may be.

In finding the approximate circu ence of a circle, would it not be to multiply by 22 and divide by 7 than to multiply by the more awl yet more accurate constant 3.1416 for approximate work the former n is plenty good enough.

In finding the diagonal of a would we not multiply the side l constant 1.4142 rather than extra square root of the sum of the squa the sides, and to find the long dia of a hexagon would we not multip the constant 1.1549 rather than to it out in a number of more lab ways? In the two latter cases, t sults will be inaccurate simply b we cannot get a complete decimal.

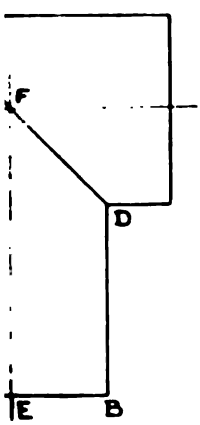
If in mathematical work we ca these short cuts to advantage it will pay at times to resort to r thumb methods in our graphical and I submit herewith two short m of laying off, approximately, the de ment or pattern of two different of elbows. While these are only cu

hods they will be found to ap-
te so closely to the theoretical
, that any trimming to fit will not
red.

g. 1 we have a view of a right
bow in two pieces. The pattern
vertical pipe is shown in Fig. 2.
in Fig. 2, lay off KL equal in
o 3⅛ times the diameter A B.
will be seen, is another approxi-
one much more readily laid off
r enough to the theoretical to be
cially correct. Next divide KL
r equal parts and erect perpendic-
K L at the five points shown.

that may be required, the pattern is complete.

Still more time may be saved by discarding Fig. 1 entirely, knowing the diameter A B and the distance B D. Without Fig. 1 the distance K L may be figured, laid off and divided as in the previous case. K P and L V will equal B D, and N S will equal the sum of B D and A B. Having given the points P, S and V to find R and T, connect P and S, also S and V, by straight lines and their intersections, respectively, with M R and O T will give the required points. The remainder of the figure may be



ig. 1.

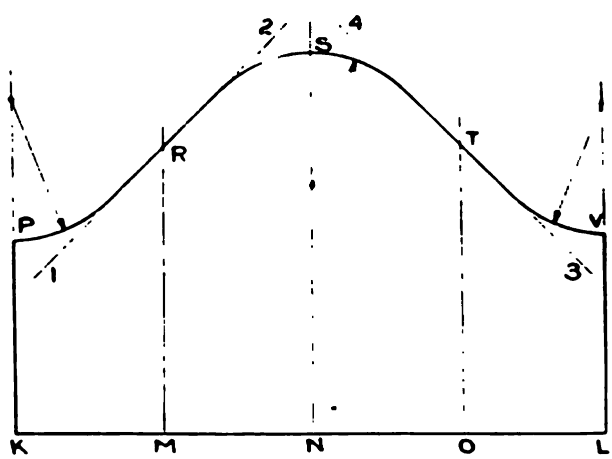


Fig. 2.

I R and O T equal in length to
ig. 1) and through the points R
draw the straight lines 1-2 and
king angles of 45° with K L.
; S equal to A C and L V and
al to B D. Find, by trial, a point
ine N S which will be the center
c passing through S and tangent
and 3-4. With the same radius
nter on the extension of the line
aw an arc through P tangent to
1-2; and in a similar manner
e same radius draw an arc
the point V and tangent to the
After adding any further lap

drawn as previously described.

In Fig. 3 is shown elevation of three part elbow and in Fig. 4 we have the pattern for the vertical piece. To obtain this, approximately, lay off K L equal to 3⅛ times A B, divide into four equal parts and erect perpendiculars at the points of division. Lay off on these perpendiculars K P and L V equal in length to B D, M R and O T equal to E F and N S equal to A C. Through R draw the straight line 1-2, making the same angle with K L as C D makes with A B. In a similar manner through T draw the line 3-4 having the angle with K L equal

to the angle made by C D with A B.

With a center on S N draw an arc through S tangent to 1-2 and 3-4. With a center on L V extended draw an arc through V tangent 3-4, and with a center on the extension of K P draw an arc through P tangent to 1-2. The same principle may be applied to any multi-part elbow.

Wetting Lead Pencils.

The act of putting a lead pencil to the tongue to wet it just before writing, which is habitual by many people, is one of the oddities for which it is hard to give any reason, unless it began in the days when pencils were poorer than now, and was continued by example to the next generation. A lead pencil should never be wet. It hardens the lead and ruins the pencil. This fact is known to newspaper men and stenographers. But nearly every one else does wet a pencil before using it. The fact was definitely settled by a newspaper clerk away down East. Being of a mathematical turn of mind, he ascertained by actual count that of 50 persons who came into his office to write an advertisement or a church notice, 49 wet a pencil in their mouths before using it. Now, this clerk always uses the best pencils, cherishing a good one with something of the pride of a soldier feels in his gun or his sword, and it hurts his feelings to have his pencils spoiled. But politeness and business considerations require him to lend his pencil scores of times a day. And often, after it had been wet till it was hard and brittle and refused to mark, his feelings would overpower him. Finally he got some cheap pencils and sharpened them, and kept them to lend. The first person who took up the stock pencil was a drayman, whose breath smelt of onions and whiskey. He held the point in his mouth and soaked it several minutes, while he was torturing himself in the effort to write an advertisement for a missing bulldog. Then a sweet-looking young lady came into the office, with kid gloves that buttoned half the length of her arm. She picked up the same old pencil and pressed it to her dainty lips preparatory to writing an advertisement for a lost bracelet. The clerk would have stayed her hand, even at the risk of a box of the best Dixon pencils, but he was too late. And thus that pencil passed from mouth to mouth for a week. It

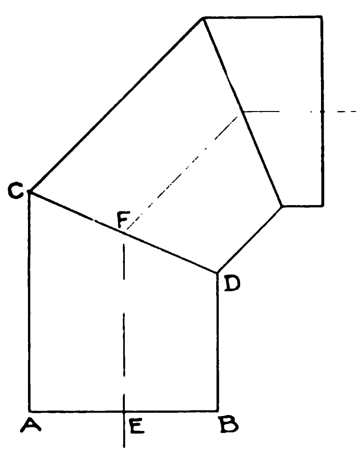


Fig. 3.

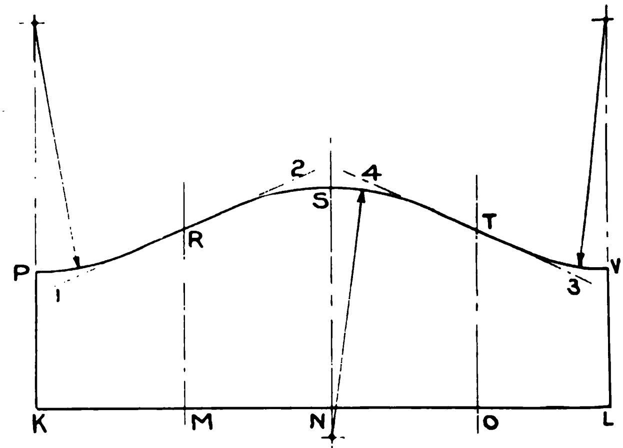


Fig. 4.

cked by people of all ranks and , and all degrees of cleanliness cleanliness. But 'twere well to . Surely no one who reads this r again wet a lead pencil.—From k.

Lacing and Lattice Work.

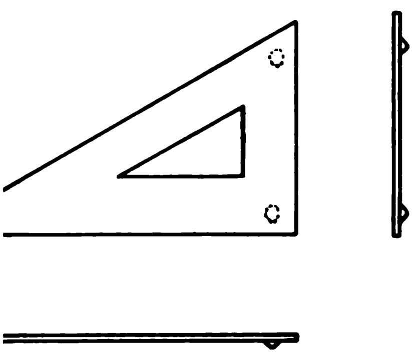
mns and steel structures are often ed of I beams or channels stayed gonal bars called lattice bars. he diagonal stays or braces of this do not cross each other at any etween their ends they are some- known as lacing and the term bars is evident.

me specifications bars are called have one rivet at each end and of about three times the diameter rivet and the thickness is from 1/4 ich.

8 inch channels, a bar 1 3/4 by 1/4" en found sufficient and they incline at an angle of 60° of the a column.

Draftsman's Triangle.

accompanying sketch shows an in- nt. in the main, familiar to all ien. The common celluloid tri- fitted with three feet, as indicated, s quite a useful addition to the s" set of tools. These feet may e of any material at hand, fastened under side of triangle so as to ele- me about 1-16" from the drawing. arrangement as shown may have



numerous advantages, principal among which are the following two: First, in a great many instances, during the process of inking (tracing) it is necessary or de- sirable to move back over portions not yet dry, which by this method is made possible, saving time and preventing a blot or smear. Again, every draftsman remembers that time when he could have made use of a little more reach, at right angles to working edge of triangle, when pinning one line to another, etc. By this method, the fulcrum of pen is elevated to a greater degree thereby allowing wider variation at pen point.

It is hardly probable that blotting will result due to pressure of hand on tri- angle, during the process of line draw- ing.

It is handy to have such an instrument ready should occasion demand.

ABOVE BOARD.

Strength of Slag Cement, Building Brick and of Slag Concrete.

[A Thesis presented for the Degree of Bachelor of Sci- ence in Civil Engineering at Case School of Applied Science by D. N. Beers and C. C. Lanken.]

The objects of this thesis were to de- termine the strength of building brick made of slag and cement; sand and ce- ment; and sand, stone and cement; and of the slag concrete used in the construc- tion of the Walsh-McGuire building, Cleveland, Ohio, with a view of com- paring the strength developed by each with each of the others, and with stan- dard building materials of each class.

It was further desired to obtain a com- parison between the strength of this con- crete made for actual use in a commer- cial way, and of concrete made in a labo- ratory for testing purposes only.

From the results obtained it was evi- dent that the strength of the brick in- creases with time; that the strength of the brick depends directly upon the per cent. of cement; that above 9% cement

the strength increases very much more per additional per cent. of cement than below this point; and that this increase in strength per cent. itself increases rapidly as more cement is added, up to at least 16%. It appears that the limit to this increase per cent. is reached at about 30% for 28 day strength, and 35% for 14 day strength.

From the comparisons of the compressive strength of slag cement brick with that of ordinary brick it appears that slag brick poorer than 10.1 are worthless as building material.

As to the comparative strength of sand cement, and slag cement brick, the poorer mixes of sand and cement have no strength at all, while similar mixes of slag and cement show considerable strength. This difference is undoubtedly due to the cementing properties of the slag. Of the mixes richer than 10.1 where the sand cement brick begins to attain strength, the slag brick develops the greater strength. This is also due to the cementing properties of the slag. This difference would undoubtedly be greater if the slag were more finely ground.

Besides that for compression, heating and freezing tests were made on the brick. The former test was made by putting samples of each brick in the furnace of the Cleveland City Forge Co., and subjecting them to a temperature of 1000° F. for twenty-four hours. The freezing test was made by putting three samples of each brick in one of the ice cans used in the manufacture of artificial ice, and alternately freezing, thawing, drying, freezing, etc., three times. When frozen the bricks were encrusted entirely in a cake of ice, thus receiving a far more severe freezing test than that to which they would ever be subjected in a wall.

All of the brick subjected to a heating test by being burned in a furnace at a temperature of 1000° F. for twenty-four hours, crumbled, except the 4-1, 5-1, and 6-1 slag cement mixes. The latter lost practically all their strength and were worthless.

Some common clay brick which were tested showed losses of strength of over 50% due to being frozen and thawed but once. The maximum loss due to freezing and thawing three times of the slag cement brick was 33½%, and of the sand-stone-cement brick 29.4%. From this it is evident that both of these kinds of brick resist the action of frost better than the common clay brick.

The Use of the Level.

Leveling is the process of finding the difference of level of two places or the distance of one place above or below a level line through another place.

A *level surface* is one parallel with the surface of still water and a *level line* is a line in a level surface.

With these few remarks before us, we see what is to be accomplished and what must be kept in mind when a person is asked to do leveling.

Fig. 1.

The instruments used are the level, Fig. 1, consisting of a telescope, tripod and plumb line and the leveling rod Fig. 2.

[T]he spirit level under the telescope as-
s in getting the instrument in correct
ndition for work.

[L]et it be considered that the man op-
ting the level is the observer and the
at the rod, the rod-man, and let it
required to find the difference in level
two points *A* and *B*.

[T]he point at which the level is set is
led a *station* and at some point about
f way between A and B, the instru-
nt is set up on the tripod and ad-
ted.

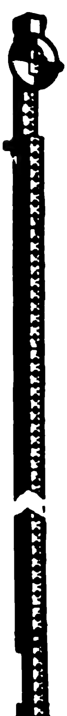


Fig. 2—Level Rod.

It will be seen from the illustration
t the head is controled by four milled-
ad screws.

After setting the legs of the tripod
art sufficient to bring the telescope up
with 4 or 5 inches of the eye of the
server and as near level as possible,
ss them firmly into the soil.

Swing the telescope over one set of screws and level by turning them in or out with thumb and fingers but be careful not to bind them tight.

When the bubble in the tube is central, swing the telescope over the other set of screws and repeat the process, then return to former position and correct for any variations that may have been caused by the second adjustment.

The rod shown in the illustration consists of two pieces of wood, sliding one upon the other and held together in any position by a clasp

The front surface is graduated to hundredths of a foot up to 6½ ft. A target slides along the front of the rod and is held in any position by a clamp.

It has a square opening at the center, through which the division line of the rod opposite to the horizontal line of the

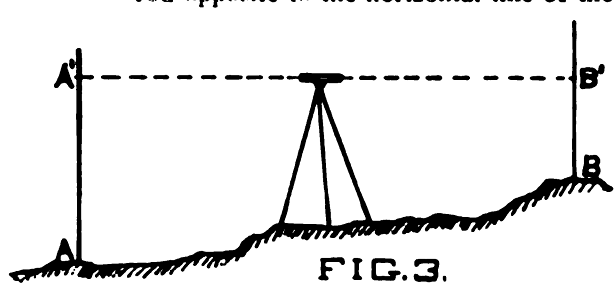


FIG. 3.

target may be seen. It carries a vernier by which heights may be read to thousandths of a foot.

If a greater height than 6½ feet is desired, the target is made fast with its horizontal line at 6½ feet from the lower end and the back part of the rod moved up until the target is at the required height.

After leveling the instrument, direct the rodman to place the leveling rod vertically at A. Bring the telescope to bear on the rod and by signaling have the rodman slide the target until its horizontal line is in the line of apparent level of the telescope or coincides with the hair line to be seen in the instrument.

Let the rodman record the height A A'

of target and proceed to B, find B B′ by swinging the telescope and adjusting the target to suit the observer.

The difference between A A′ and B B′ will be the difference of the level required.

If the instrument be set up at one station, say at A, and the rod at the other, the difference between the heights of the optical axis of the telescope and the target, corrected for the curvature and refraction, will be the difference of level required.

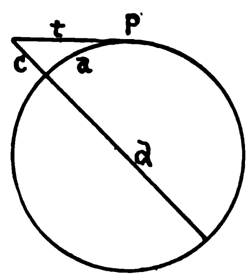


FIG. 4.

If the instrument be set up about equal distance from A and B, no correction for curvature of the earth need be made.

The correction for curvature is the deviation of the line of apparent level from the level line for any distance. Let t, Fig. 4 represent the line of apparent

approximately. Since c is very small compared with d and $t = a$ without appreciable error. Since d is constant (7,920 miles, nearly) the correction for curvature varies as the square of the distance.

For example, what is the curvature for one mile? By substituting in the formula

$$c = \frac{a^2}{d} = \frac{1^2}{7920} \text{ mi.} = 8 \text{ in. nearly.}$$

Hence the correction for curvature may be found approximately, by multiplying 8 by the square of the distance expressed in miles. A correction for the refraction of the ray of light is sometimes made by decreasing the correction for curvature by 1-6th of itself.

To find the difference of level of two places, one of which cannot be seen from the other, we locate the instrument between the first station *A* and an intermediate place as *B*, Fig. 5. Find A A′ and B B′ as in the preceding case and record the former as a ***back sight*** and the latter as a *fore sight.* Locate the instrument ahead of the point B and with the rod at C, find C C′ and record it with reference to the back sight B B″.

Repeat the operation as often as neces-

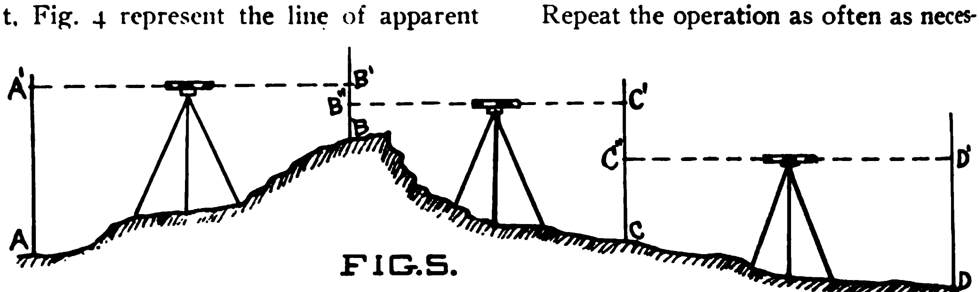


FIG. 5.

level of the place *P*, *a* the level line, *d* the diameter of the earth, then *c* represents the correction for curvature. To compute the correction for curvature, $t^2 = c\ (c + d)$ therefore

$$c = \frac{t^2}{c+d} = \frac{a^2}{d}$$

sary to carry the amount of difference from A to D, C C″ being a ***back-sight*** and D D′ the foresight.

The difference betwen the sum of the foresights and the sum of the backsights will be the difference of level required.

the contractor, the level is an le instrument, allowing him to lo- lers and other foundations with ty and rapidity.

ctions for adjusting the various if the level are sent with each in- nt and should be followed care-

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sing Pressures of Bessemer Steel -Welded Tubes, 3 to 10 In. Dia.

. R. T. Stewart, Allegheny, Pa., ien perfecting a series of tests are to determnie the collapsing e of lap welded tubes.

following is an extract of the re- ken from the paper as presented meeting of the American Society hanical Engineers at Chattanooga, 1906.

s research was undertaken for the e of supplying an urgent demand iable information on the behavior dern wrought tubes when sub- to fluid collapsing pressure. Every known to engineering science that id in the accomplishment of this aking has been used, and every e effort made to get at the truth ve the research yield trustworthy It was planned and executed un- e immediate direction of the au- it the McKeesport works of the al Tube Co. and has occupied for mpletion, during a period of 4 the time of from one to six men.

es One.—This series of tests was in tubes that were 8⅝ inches out- ameter, for all the different com- l thicknesses of wall, and in of 2½, 5, 10, 15 and 20 feet be- transverse joints tending to hold e to a circular form. The chief e of this series of tests was to fur- ata for determining which of the g formulae, if any, were applicable ern lap-welded steel tubes, especially when used in comparatively long lengths, such as well casing, boiler tubes and long plain flues.

Series Two.—This series of tests was made on single lengths of 20 feet between end connection, tending to hold the tube to a circular form. Seven sizes from 3 to 10 inches outside diameter, and in all the commercial thicknesses obtainable, have been tested to date. The chief purpose of these tests was to obtain, for commerci..l tubes, the manner in which the collapsing pressure of a tube is related to both the diameter and thickness of wall.

Inapplicability of Previously Published Formulae.—Preparatory to entering upon the present research all existing published formulae that could be found were collected, and, after the completion of series one, were tested as to their applicability to modern steel tubes. Among the formulae thus tested were two each by Fairbairn Unwin, Wehage and Clark, and one each by Nystrom, Grashof, Love, Belpaire and the Board of Trade (British), all of which, with possibly two exceptions, appear to be based upon Fairbairn's classical experiments, made more than a half century ago, upon tubes wholly unlike the modern product. Without exception, all of these formulae, when thus tested, proved to be inapplicable to the wide range of conditions found in modern practice. As an illustration of this the very first tube tested in connection with this research failed under a pressure that exceeded by about 300 per cent, that calculated by means of Fairbairn's formula.

Results of Present Research.—The principal conclusions to be drawn from the results of the present research may be briefly stated as follows:

1. The length of tube, between transverse joints tending to hold it to a circular form, has no practical influence upon

the collapsing pressure of a commercial lap-welded steel tube so long as this length is not less than about six diameters of tube.

2. The formulæ, as based upon the present research, for the collapsing pressure of modern lap-welded Bessemer steel tubes, are as follows:

$$P = 1{,}000\left\{1 - \sqrt{1 - 1{,}600\frac{t^2}{d^2}}\right\} \qquad (a)$$

$$P = 86{,}670\frac{t}{d} - 1{,}386 \qquad (b)$$

Where P = collapsing pressure, pounds per sq. inch.

d = outside diameter of tube in inches.

t = thickness of wall in inches.

Formula A is for values of P less than 581 pounds, or for values of $\frac{t}{d}$ less than 0.023, while formula B is for values greater than these.

These formulæ, while strictly correct for tubes that are 20 feet in length between transverse joints tending to hold them to a circular form, are, at the same time, substantially correct for all lengths greater than about six diameter. They have been tested for seven diameters, ranging from 3 to 10 inches, in all obtainable commercial thicknesses of wall, and are known to be correct for this range.

For the convenience of those who wish to apply these formulæ to practice a table has been calculated, giving the collapsing pressures of all the commercial sizes of lap-welded tubes from 2 to 11 inches outside diameter.

For those who prefer graphical methods Charts were constructed, with an explanation of their use.

When applying these formulæ, tables and charts to practice, it should be remembered that a suitable factor of safety must be applied.

3. The apparent fiber stress under which the different tubes failed varied from about 7,000 pounds for the relatively thinnest to 35,000 pounds per square inch for the relatively thickest walls. Since the average yield point of the material was 37,000 and the tensile strength 58,000 pounds per square inch, it would appear that the strength of a tube subjected to a fluid collapsing pressure is not dependent alone upon either the elastic limit or ultimate strength of the material constituting it.

The result of this test when written up covers 87 pages of the proceedings of the Society of Mechanical Engineers and forms a part of Volume 27 of their transactions.

Sizes of Paper.

There are a large number of makes of paper but the manufacturers have confined themselves to a few general sizes.

Papers are classed under the following heads, but this is not absolute, each maker having classes for his own particular brand.

These are print, book, music, cover, label, blotting, card boards, tag boards, flat writing, linen, bond. ledger, tissue, wrapping, wax and parchment papers and straw boards.

All of the above are made in various sizes and weights and nearly all sold with 500 sheets to the ream.

The weight mentioned is that of a ream except in the case of card, tag or straw boards where it applies to 100 sheets.

Names have been given to a lot of sizes as follows:

"SIZES OF FLAT PAPERS."

Ordinary.

Cap	14 x 17
Demy	16 x 21
Folio	17 x 22
Medium	18 x 23
Royal	19 x 24
Double Cap	17 x 28
Super Royal	20 x 28
Double Demy	21 x 32

ˀolio	22 x 34
ledium	23 x 36
loyal	24 x 38

L

....	10 x 16
....	13 x 16
....	15 x 19
l. Demy	16 x 42
l. Med...............	18 x 46
....	23 x 31
....	23 x 28
lephant	27 x 40
r	23 x 34
....	26 x 33
ian	31 x 53

can be secured in several o the ream and are always laid

papers are made with a "water nning through each sheet which e use when sketches there are to rinted.

pplies to bonds, linens and led- is often a great disadvantage e papers have a fine surface for

papers are made in sizes 16 x 22, 19 x 24 and 17 x 28 only, only certain grades are made

lio (17 x 22) is the size used for ds, being cut 8½ x 11, which is d a standard for a full size sheet ommercial letter writing.

apers are made in sizes 22 x 28, 25 x 38, 28 x 42, 30 x 44, and ut not in all weights and do not ry good surface for drawings.

boards are made in practically 22½ x 28½, but in several anging from 2 to 8 and in a iety of colors.

dinary calling card is about 2 nany of the index cards 3 ply.

The Star Photo-Printing Machine.

[Being the report of the Franklin Institute through its Committee on Science and the Arts, on the invention of Prof. L. F. Rondinella, of Philadelphia Reprinted from Journal Franklin Institute, January, 1906.]

The Franklin Institute, acting through its Committee on Science and the Arts, investigating the merits of the "Photo-Printing Machine," by Prof. L. F. Rondinella, of Philadelphia, Pa., reports as follows:

This is an apparatus for producing photographic prints in continuous form from tracings or other flexible transparencies of unusual length.

The form of the apparatus under present consideration, to which the inventor has given the name of "Star Photo-Printing Machine," is designed esepcially for the practice of the blue-print and paper-negative processes, and was patented March 19, 1901, No. 670,349. The machine is adapted to print by sunlight or artificial light as may be most convenient, and accordingly comprises two independent parts, the printing machine proper and the electric lighting apparatus upon which it is supported.

The printing mechanism is contained in a casing which is provided with ball casters so as to be easily rolled out from its support upon tracks arranged for the purpose through a window for sun-printing. The casing is made of well-finished oak and contains all the requisite materials of the printing process throughout and also all the mechanism of the apparatus except the small electric driving motor and its reducing gears. These are fixed on the exterior, on one side of the machine. The casing is curved on top, whence it runs down into a slant of about 45° and then projects to form a receiving compartment at the front. The covers of the slanting and horizontal parts are hinged together and to the front edge of the casing, forming a two-leaved lid

which, when lifted and brought forward, opens the machine and at the same time forms a projecting work table. This hinged cover may also be brought to rest in two other positions, leaving the machine only partially open and the work table out of the way. The curved section of the casing is covered with a roll-top shutter which serves as a covering slide over the exposure opening, permitting this to be varied in extent up to 105° for rays from the sun and up to 120° or more for those from the electric lamps.

The printing is effected through a transparent covering-sheet which holds the tracing and sensitive paper down upon the surface of a felt-covered drum that revolves under the exposure opening concentrically with the curved top of the casing. The transparent cover consists of a strip of the best tracing cloth over seventy feet in length, permanently fastened at one end to the drum and passing around this to a winding roll under proper tension. The tracing cloth is carefully prepared so as to wind true from roll to drum and back again, and its edge is spaced off into feet and marked with numbers which indicate the maximum length of print which may yet be made when part of the cover has been wound off. The cover-strip passes from its winding-roll up under an idler and then around this down to its contact with the drum, the material thus forming an inclined feed-apron down which the tracing and sensitive paper are carried into contact with the revolving drum, and thence around with it under the exposure opening. The printing is continued on the return of the drum, and after the printing the tracing and prints are carried up the inclined plane and delivered over the idler into the receiving compartment in front. The tension of the transparent cover can be regulated by means of a friction brake at one end of the winding roll and can be effectively controlled so as to insure a close contact of the sensitized paper with tracings on thick or rumpled tracing cloth at any desired printing speed.

Star Photo-Printing Machine, with casing closed.

The drum is actuated from the outside by means of a reducing gear-couple from the motor to a driving spindle which passes into the casing and carries a small pinion on its inner end. This spindle is movable laterally so as to carry the pinion into mesh with either of two sets of reducing gears on the inside, one set serving to move the drum forward at a certain speed and the other to move it backward at a faster speed. The spindle is held in either position by means of a

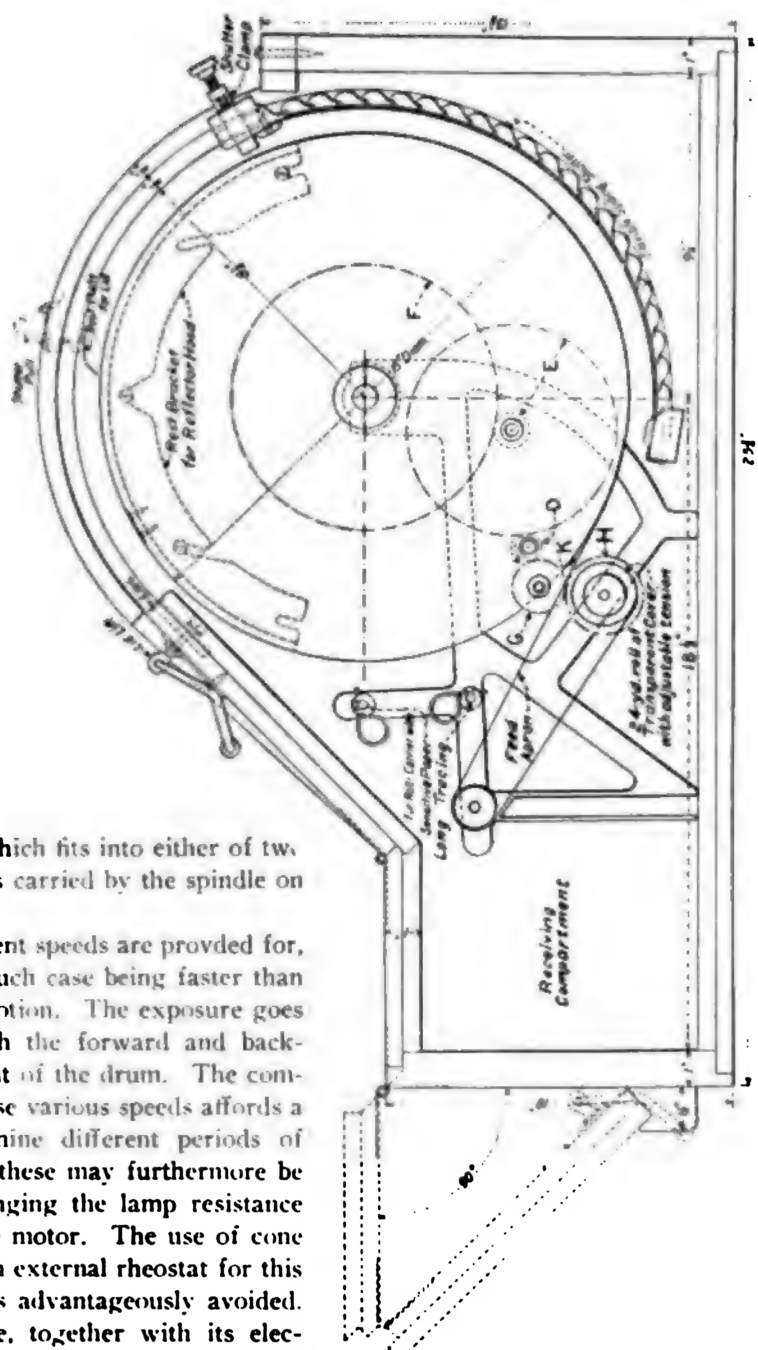


Fig. 2: Star Photo-Printing Machine, end view of inside mechanism.

spring catch which fits into either of two grooved collars carried by the spindle on the outside.

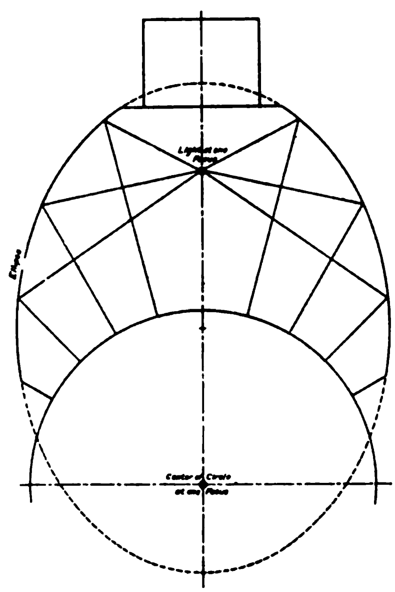
Three different speeds are provded for, the return in such case being faster than the forward motion. The exposure goes on during both the forward and backward movement of the drum. The combination of these various speeds affords a gradation of nine different periods of exposure, and these may furthermore be varied by changing the lamp resistance attached to the motor. The use of cone pulleys or of an external rheostat for this purpose is thus advantageously avoided.

The machine, together with its electric-light supporting frame, is built in three widths, affording prints up to thirty, forty-two and forty-eight inches wide respectively, all three being adapted to make continuous prints up to a length of seventy feet.

The electric-light Support of this machine, though an extraneous feature of the apparatus, must yet in view of the practical requirements of any considerable drafting room or of a comme

blue-printing establishment, be regarded as of primary importance. The support is so wired as to be ready for connection to the mains of either a two- or three-wire system carrying 110 or 220 volts, direct current. The lighting arrangement consists of enclosed-arc lamps, four, five or six of them for the three respective widths of the machine, or of a set of three or four Coper-Hewitt mercury lamps of the requisite length.

PRINCIPLE OF RONDINELLA'S ELLIPTIC REFLECTOR FOR CIRCULAR SURFACES



The most actinic rays of light from an arc lamp radiate in a beam outward and downward from the crater formed by the arc in the upper carbon, and the idea is to so reflect all the rays as to bring about a zone of uniform actinic force over the entire surface of the exposure opening of the machine. To this end the lamps are placed directly over the axis of the drum, under a reflector-hood especially designed for the purpose upon the principle of reflection from the surface of an ellipse, as first demonstrated by the present inventor before the Franklin Institute, at its meeting on December 21, 1904. The lamp and the enclosing reflector-hood are both hung from a suspension beam adapted to be raised and lowered on the support over the machine, the lamps being held to the beam in a fixed position and the hood by chains that permit its being raised and lowered about the lamps. Through sight-holes placed for the purpose the hood can be adjusted over the lamps so that the arcs coincide with the focal line of the elliptical inner surface of the hood. In this position all the rays that strike the inner surface are reflected towards the opposite focus of the ellipse. The suspension beam with its lamps and hood is then lowered until the ends of the reflector hood rests upon the bracket at the two ends of the machine casing. Thus placed, the reflected light is intercepted by the cylindrical surface of the drum, reaching it and its overlying tracing and sensitized paper in rays of equal length and in directions uniformly normal to the surface, thus producing the desired area of uniform illumination. For the long tubes of the mercury lamps, the same principle is applied in a form modified for the purpose. In either case the uniformity of illumination which is produced is such that tracings coming within the area of the opening can be effectively printed without moving the drum.

The Rondinella Photo-Printing Machine marks a distinct advance in the practice of this art. Long prints, whether from negatives or from tracings, were formerly produced by simply pasting shorter ones together or by the obviously difficult and unsatisfactory method of making the continuous print by successive exposures of shorter sections. To obviate the imperfections inevitable in either of these processes, various expedients have been resorted to, one method being to fasten the sensitized paper with its over-lying flexible transparency on a

d of sufficient size in width and h, springing the board lengthwise to the material into the best possible act over the convex surface and exposing to as even light as possible. ffort to replace these crude proced- with a mechanism for the purpose made some fourteen years ago by Heinze, of Chicago, Ill., whose in- ion was patented No. 469,244, on

two materials, the diameters of the two rolls would be or would soon become different, and unequal lengths of the two materials would be drawn off in the same time. In the course of the rotation, the two sheets were drawn under a succession of scrapers spanning the exposure opening, the scrapers serving to smooth out the sheets and to force them into printing contact. The machine seems to

3—Support for Star Photo-Printing Machine and electric equipment.

ruary 23, 1892. In that device the ing and sensitized paper were each e separately rolled upon spools from ch they were then drawn off together the rotation of a drum to which the r ends of both were fastened. These ls were geared so as to make the e number of revolutions, but on ac- t of the different thicknesses of the

have been devised especially for printing by daylight alone and appears never to have been brought into practice. The Rondinella machine of 1901 is the next on the record, and the first to meet the practical requirements of the occasion. It has been followed by several others, most of them utilizing a rotating drum on which to effect the exposures, but

manifestly retains its leading place as an efficient solution of the problem.

In view of the scientific accuracy and mechanical thoroughness and simplicity with which all the various requirements of the process of continuous photo-printing have been fulfilled in this machine, the Franklin Institute recommends the award of the John Scott Legacy Premium and Medal to the inventor, Prof. Lino F. Rondinella, of Philadelphia, Pa.

Fig. 5—Star Photo-Printing Machine in its support, as used for printing by electric arcs.

The Clay Engineer.

The clay workers of America, especially those engaged in the manufacture of structural products, in which so much capital is invested have come to realize the benefits to be derived from employing an engineer to investigate their propositions and make complete plans and specifications for the construction of new plants and for the improvement of old ones.

In view of this, The Richardson-Lovejoy Engineering Co., has been formed at Columbus, O., to contract for work along this line. The company will be able to take up all phases of handling the materials in and about a clay working plant.

The Natural Slope of Broken Stone.

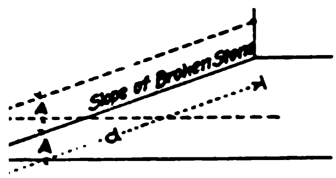
The following tabulation of the slope of broken stone was given in *Engineering-Contracting*.

The stone was piled in stock piles at the East Basin of the Jerome Park Reservoir of New York City.

A steam shovel was used in loading the material into cars, the excavation

ıe at the bottom of the pile. per portion of the pile assumed slope by gravity action, in the ner as a "talus" at the foot of a

sketch below *A* is the angle and D is the distance taped on

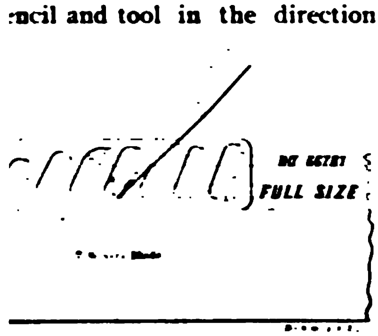


Angle (A)	Distance on Slope D
+37°-43′	27 ft.
+39°-06′	32 "
+36°-48′	33 "
+35°-12′	39 "
+35°-22′	47 "
+36°-28′	49 "
+35°-58′	54 "
+36°-48′	56 "
+37°-08′	52 "
+36°-05′	38 "

erage of the angle was 38° 28′ equently the slope was about

ın's Device for Drawing Letter Space Lines.

ındy little tool I use for draw- space lines. To use it I place the T-square blade, as shown tch, with the pencil point on at the lower angle A. By the angle draw the line D by mov- encil and tool in the direction



of the arrow; draw the line D′ by the aid of the upper angle A, and the lines D and D′ will be 5/32 inch apart. By placing the pencil point at the points B and following the same process the lines C and C′ will be drawn ⅛ inch apart. E is a small knob or handle to pick it up by. The small rectangles with a dot in the center show where the notches were beveled off to let the pencil tilt. I made mine of gutta percha 1/16 inch thick, but it could be made of thin wood or celluloid.—F. W. Bach, in *Machinery*.

A Manual of Drafting Room Practice.

The chief draftsmen of the large manufacturing plants where the men are changing frequently find it necessary to put before each beginner a copy of the "rules of practice" of that particular drafting room. This is done in order that the work of that man may conform as nearly as possible to what had been made before.

It has been found that when a man changes from one drafting room to another that the "rules of practice" is so different in many respects that he must start all over again. An old man in the business generally adapts himself to circumstances, but a new one is often confused at the diversity of opinion.

Of course, some may say that their practice is as good as any other, and in many cases there is a similarity, so that if all the "rules of practice" could be put up to some able committee a manual could no doubt be formulated that would become practically universal.

The writer has been told that certain concerns are very strict about their drafting room data book, but aside from the guarding of the actual sizes of the machines manufactured, there is no need of such extreme care.

The editor of this magazine has requested copies of drafting room practice from a large number of concerns with

the idea that a manual could be compiled giving the best of all rules and regulations.

There are a great many books on drawing, but few if any give the practice as used in the largest drafting rooms of the country, and the instructors of drawing classes are at sea on the subject.

This compilation will be introduced into the schools and colleges of the country to enable the student to get a clearer idea of the requirements in the drafting room, and show him the uses in everyday practice.

A convention of prominent draftsmen of the country could take up such matters and discuss them, and no doubt reach conclusions that would tend to standardize many things connected with drafting room practice.

Any one having copies of "Rules of Practice" in the drafting room in which they are at work, and can consistently do so, please send them to the editor of the magazine.

QUESTION BOX.

(This department is in charge of Mr. A. B. BABBITT, Hartford, Conn., and questions will be answered more promptly if sent directly to him. The department is intended to give correct answers to questions of general interest. Make your question complete. Name and address must accompany each query, although neither will be published.)

4. How do you calculate the centrifugal force produced by weight A, of a shaft governor when the bar B is 12 inches long and the weight of A is 25 pounds? Speed of shaft is 200 R. P. M. See Fig. 1.

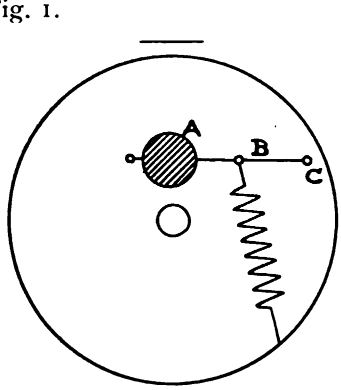


Fig. 1.

The centrifugal force is not dependent upon the length of the weight arm B, but varies as the radius of revolution, that is, the distance from the center of the shaft to the center of gravity of the weight. Having this given and the other conditions as named in your problem, to find the centrifugal force multiply the weight in pounds by the radius of revolution in feet times the square of the number of revolutions per minute and divide by 2936, or

$$F = \frac{WRn^2}{2936}$$

In which W is the weight of the rotating body in pounds, R is the radius of revolution in feet, N the number of revolutions per minute and F the centrifugal force.

Assuming the distance from the center of the shaft to the center of gravity of the weight to be eight inches and substituting in the above formula the value given in your question, we have,

$$F = \frac{25 \times \frac{2}{3} \times 200^2}{2936} = 22.7.$$

5 How strong a spring will be required or are they just strong enough to overcome the centrifugal force? See Fig. 1.

The centrifugal force is resisted by these springs whose duty it is to pull the weights towards the shaft. Any spring will give the right variation at some speed and to determine the point where the springs will act best, screw up the springs until the engine begins to "hunt" and then loosen them until the governor is sensitive yet the engine runs steadily.

ENGINEERING REVIEW.

icturing Raw Hide Leather aces" is discussed in the *Phoe-ly, N. Y.*, for April.

iufacture of lace is a business id separate from the leather t is confined almost entirely to s. Five pages and from illus- the article.

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p where the sand blast is now for cleaning crown bars and ets, it formerly took a 17½ o hours to clean a dozen bars r the lot.

: sand blast a bar is cleaned in iinutes, or about half the time ig the old way.—*Boiler Maker.*

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ns of Formulae for single and ression; also, Proof of Condi- erning Best Proportions and onomy in Stage Compression. and illustrations on 16 pages lations by Edw. F. Schaefer. *sed Air*, March, 1906.

Shop Costs. By G. C. Keith. paying systems, rates, time check. Illustrated with dia- i *Canadian Machinery*, April,

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Smelting Assured. Dr. Dominion Superintendent of tes results of experiments in ielting at Sault Ste. Marie in *Machinery*, March, 1906.

Balancing of Gasoline Engines. Reprint of an article in the English *Autocar*, by Archibald Sharp. Diagrams and formulae in *The Gas Engine*, April, 1906.

Costs in Handling Materials and Work Done.

From *Engineering-Contracting and Roadmaster and Foreman.*

The April issue of magazine is given the record of cost of brick work on five buildings forming part of a manufacturing plant. Work was done by the owners, hiring their own labor.

The cost of the work per 1000 brick was as follows:

Bricklayers @ 60c per hour......	$4.16
Helpers @ 17½c per hour.......	1.87
Carpenters @ 20 to 22½c per hour	.77
Handling materials	1.10
Total labor	$7.90

In this the carpenters were used to build scaffolds.

Cost of materials per 1000 brick was $7.43 (average) or a total of $15.39 including labor.

This converted into cost per cu. yd. of masonry was $7.60. Some of the buildings were long and low, containing about equal amounts of 9" and 13" walls, others with 13, 17 and 22" walls.

Cost of Power.

Iron Trade Review.

Out of the several items constituting the operating cost of power, viz., fuel, labor, supplies, and repairs, fuel is, of course, the most important, and it is

worth while pointing out here how easily one may be fooled in making comparisons between steam plants and gas plants. In a high grade steam plant the cost of coal usually runs from 55 to 65 per cent. of the total cost. This leaves about 20 per cent. for labor, the same amount for repairs, and the balance for supplies. In a producer gas plant on the other hand, the fuel item is proportionately smaller, in fact from 35 to 45 per cent. of the total operating costs. This necessarily places a larger per cent. of the costs upon the remaining items. Hence in comparing the distribution of costs between steam and gas stations it may readily occur that the latter shows a higher percentage in cost of labor, supplies or repairs, whereas it is relatively [illegible] in these respects.

[illegible] actual figures the operating [illegible] [illegible]

theless run with care, and intelligent attention is given when it is needed.

In a comparatively small industrial producer gas plant near Buffalo, the fuel cost, at about 50 per cent. station load factor, is 25 cents. per kilowatt-hour with a total operating cost under seven cents per kilowatt-hour, and this with coal costing $2.30 a ton. In the large central station at Walthamstow, above mentioned, where anthracite cost $6.50 to $7.50 a ton, the total operating costs were [illegible] cents for 1904, which is nearly 25 per cent. less than the average of 11 steam plants operating in the same district, but with cheaper bituminous coal. At the large railway plant at Warren, Pa., previously mentioned, the cost of fuel for running the entire urban and interurban systems, [illegible] cars averaged in January last [illegible] cents per hour, or 7½ cents per car-hour. The 35-ton interurban cars alone averaged [illegible] cents per car-hour and as the operating schedule is about [illegible] the fuel cost was [illegible] per car-mile, with gas [illegible] cents per 1000 feet in this [illegible]

[illegible] this subject the author [illegible] the fact [illegible] is not an [illegible] arrived at [illegible] active com[illegible] application, [illegible] plant is by far [illegible] special ap[illegible] being made. [illegible] oven gas, blast [illegible]

BOOKS AND CATALOGS.

BOOK REVIEWS.

ıbles of Five Place Squares and Lo-
.ms and Logarithmic Secants for Valley and Rafter work in roof de-

s is the second edition of tables for raming by Mr. G. D. Inskip and is ;ed by addition of some tables and xtension of tables in former edi-

now contains tables of 5-place es and logarithms of feet, inches 2d of inches from 0 to 100 ft., lo-.mic secants from 0 to 18 inch rise 't. base advancing by 32ds. Also thmic functions, natural sines and es for every minute of the quad-decimal equivalents and explana-of tables.

:re are 278 pages 5¾ x 7½, bound xible leather. Price $3.00. Pub-by Myron C. Clark, 13-21 Park Bldg., New York, N. Y.

'ayton Standards," is a pocket com-n for the uniform design of rein-l concrete. It is a compilation of nation acquired from actual experi-coupled with the necessary theory. r primary object of the writer in ıg these tables and details in such ı as to be available for the use of all, enable architects and engineers who not made a specialty of this class of to show the complete drawings re-d to properly illustrate a structure inforced concrete so that all con-ırs bidding upon the work will bid on a uniform basis and upon a design which is entirely satisfactory to all those concerned.

There are 110 pages, well arranged, 4 x 6, bound in flexible leather, price $3.00. Louis F. Brayton, Consulting Engineer, Minneapolis, Minn.

CATALOGS AND TRADE PUBLICATIONS.

Marion Steam Shovel Co., manufacturers of steam shovels, ballast unloaders, dredges, etc., Marion, Ohio, are preparing a catalog and if they succeed as well as they did with their last one, it will be a credit to this well known concern.

This company's shops have a capacity of completing one steam shovel a day. They have doubled their capacity in the last two or three years and they employ 1,200 men.

Fairbanks Steam Shovel Co., Marion, Ohio, are preparing a catalog on locomotive cranes of rather a novel design. These cranes are rapid in action and are built in a capacity of 5 tons.

ROBINS CONVEYING BELT CO., New York City, issued Bulletin No. 14, describing their elevating and conveying machinery for handling stone, sand and 15 707 Knowlton June 13 concrete materials, 6 x 9, 24 pages.

WELLMAN - SEAVER - MORGAN CO., Cleveland, O., issued catalog illustrating their electrically driven hoists; also bulletin on locomotive cranes, and grab buckets.

THE LAKE SHORE ENGINE WORKS, Marquette, Mich., issued catalog No. 5 illustrating their hoisting engine, rock crushers and industrial cars, 6 x 9, 44 pages.

CONTINENTAL CAR & EQUIPMENT CO., New York City, issued catalog E which illustrates and describes their several styles industrial dump cars, capacities 1½ to 8 yards, 32-page.

GEO. V. CRESSON CO., Philadelphia, Pa., issued 20-page catalog which contains a description of rope drives and advantages of various styles of grooved driving wheels manufactured by them. This also includes tables and data relative to horse power and different size rope.

THE AMERICAN HOIST & DERRICK CO., St. Paul, continue to send out their catalog illustrating and describing their hoisting engines, locomotive cranes, stiff leg derricks and builders' crane derricks.

THE ALLIS CHALMERS CO., Cincinnati, O., have issued Bulletin No. 1042, superseding Bulletin No. 1002-A, describing their type "N" motors. Direct current multiplar. This bulletin also gives illustrations showing several applications of this motor.

FRANK B. [illegible], 32 W. 20th St., New York, has issued [illegible] containing description of structures recently erected [illegible]. The list includes office [illegible] factories, [illegible]

[illegible] describing [illegible] engines [illegible] tons.

DODGE & DAY, Drexel Bldg., Philadelphia, have issued a pamphlet describing industrial plants designed by them.

INTERSTATE ENGINEERING Co., Bedford, Ohio, issued bulletin No. 7, 6 x 9, 72 pages, illustrating and describing their jib crane and locomotive crane, steam and electrically operated with and without clam shell bucket. This bulletin also includes description of cantilever crane, scraper conveyors and car hauls.

THE BROWN HOISTING MACHINERY CO., Cleveland, O., are issuing their catalog on various hoisting and conveying appliances, including locomotive, pillar, wrecking, overhead traveling, gantry and cantilever cranes. This contains 250 pages, 6 x 9.

THE BROWNING ENGINEERING CO., Cleveland, O., has just issued their No. 24 bulletin describing their locomotive cranes. This bulletin is of special interest to lumber companies and concerns interested in machinery for unloading or loading cars—16 pages, 6 x 9.

MAIN BELTING CO., 55 Market St., Chicago, has issued catalogs entitled "Facts" on Leviathan Belting. This sets forth in its well printed and profusely illustrated pages views of a number of engine rooms where their belts are transmitting power.

THE ROCKWOOD MFG. CO., Indianapolis, Ind., revised edition 5 x 9, 84-page. This catalog has been compiled and issued with the assurance that it will materially assist engineers, machinists, millwrights and operators of machinery in solving problems relating to the transmission of power by friction gearing.

THE LATE LOUIS CASSIER.

Louis Cassier, well known as the founder of Cassier's Magazine, was among the score or more of Americans who met death in the wreck of the Ocean Express at Salisbury, England, on Sunday, July 1st. Though not himself an engineer by training, he became impressed with the desirability of presenting matter of engineering interest in a more popular manner than it was generally treated of in the technical papers, and in 1891 started Cassier's Magazine as an illustrated journal of engineering, devoted more especially to mechanical engineering, power, etc. rather than the civil engineering branch. Mr. Cassier was a member of the American Society of Mechanical Engineers, the Automobile Club of America, the Republican Club, the Camera Club and the Manufacturers' Club of Philadelphia. He is survived by his widow, there being no children.

VOL. V AUGUST, 1906 NO. 8

Browning's Industrial Magazine

VESSEL LOADING MACHINES.

THE WHEELBARROW, THE CRANE, THEN THE CAR DUMPER.*

FROM the best information that can be obtained the first record of coal placed on board the lake vessels was at Cleveland, between the years of 1850 and 1856. The next record is at Lorain and Ashtabula during 1880. In 1883, there is a record of coal being loaded at Toledo, Sandusky and Fairport. At Huron, the first shipment is reported in 1886, and at Conneaut it was in 1893 that the first record appeared.

It is doubtful if any subdivision of the industries of the country has witnessed as marked an advancement as has followed the loading of coal upon the vessels at the several lake ports. The evolution has been as marked in the increased rapidity with which the coal is placed on board the vessels as in the diminution of the cost at which it is handled.

The first shipments by lake were made from the harbor of Cleveland and between the years of 1850 and 1856, which was prior to the building of the Mahoning railroad. The coal, mostly from the Mahoning Valley, came by way of canal boats, each of which held from 50 to 75 tons.

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*Some of the matter for this article is from the report of State Inspector of Mines of Ohio.

LINDSLEY CAR DUMPER.

The Lindsley Car Dumper the first car dumping machine built on the Great Lakes, was designed by Mr. Edward Lindsley, and erected in 1890 on the docks of the Cleveland, Canton & Southern R. R., Cleveland, Ohio.

During these years, it was customary to first shovel the coal from the boat on the docks, and then, for the purpose of making room, it was wheeled back out of the way. When a cargo had been collected it was loaded into barrows and wheeled on to the deck of the vessel, where it was dumped down the hatchway, allowing it to fall the full depth of the boat. At the low rate of wages then prevailing, to cast the coal from the canal boat to the dock cost 15 cents per ton and 10 cents was paid for

McMYLER END DUMP MACHINE

The Illustration shows car discharging its load into the chute, which in turn discharges the coal into the hold of the vessel.

wheeling it back. Then for loading the coal into barrows and wheeling it on board the vessels 15 cents was paid, to which five cents for trimming was added, making a total cost for transporting the coal from the canal boat on board the lake vessel, 45 cents per ton. This system prevailed for several years, when the shipments became heavier, and it became the custom to draw the canal boat alongside the lake vessel. From the side of the latter a staging was built, onto which the coal was thrown and then again shoveled onto the deck of the vessel, and then into the hatches. This dispensed with the necessity of wheeling it back as was the former

END DUMPER BUILT BY THE McMYLER COMPANY.

This dumper was first used on the docks of the Lake Shore & Michigan Southern Railroad at Ashtabula, Ohio, in 1895. Two thousand cars were especially fitted for this machine.

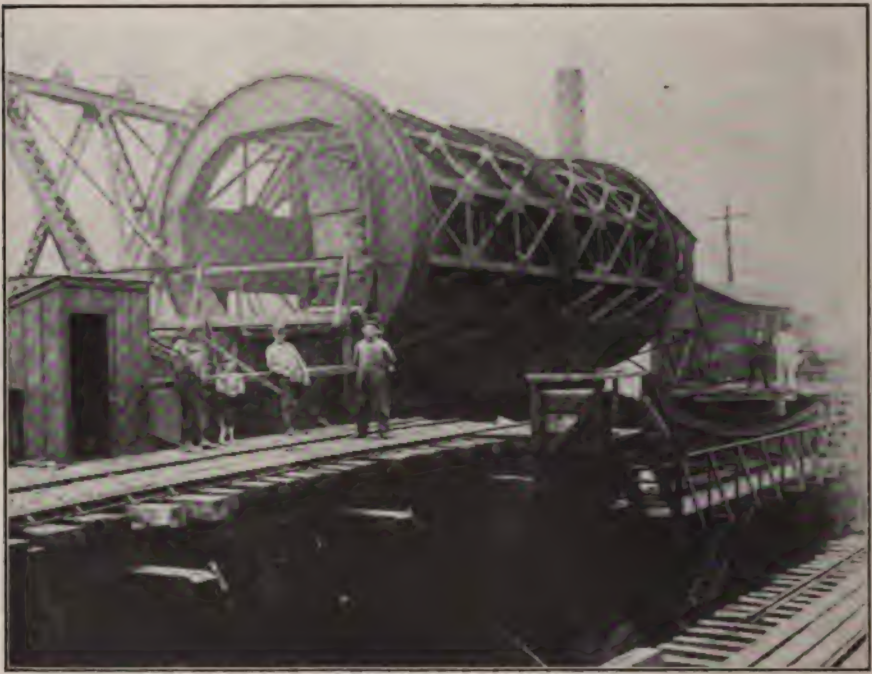
custom, and it inaugurated a saving of 10 cents per ton. The early cargoes contained from 150 to 250 tons. It was a rare thing to be able to sell more than that amount of coal to one party until about 1864, the close of the war. In fact, 500-ton vessels were the maximum until about that time, and not until after the close of the war was a vessel of a thousand-ton burden brought into the service. In the early days it was considered a good day's work with as many men as could be worked to ad-

FRONT VIEW OF THE LONG CAR DUMPER.

vantage to load a 200-ton vessel a day. In this way coal was handled until some time after the completion of the railroads, when a chute was constructed, which extended from the side of the track to the hatch of the vessel. Into this the coal was thrown from the railroad cars and allowed to slide into the boat. This system of handling coal was adopted by the Big Four road at Cleveland, also at the harbors of Ashtabula and Sandusky in a small way until about the year of 1870. The first coal from the Hocking Valley was brought to Cleveland harbor in 1869. This was unloaded directly from the cars into barrows and wheeled on board the vessels at a cost of 20 cents per ton. This was the most economical

means then in force. In this way during the summer of 1870 Babcock & Card loaded 70,000 tons, using a depot as a wharf.

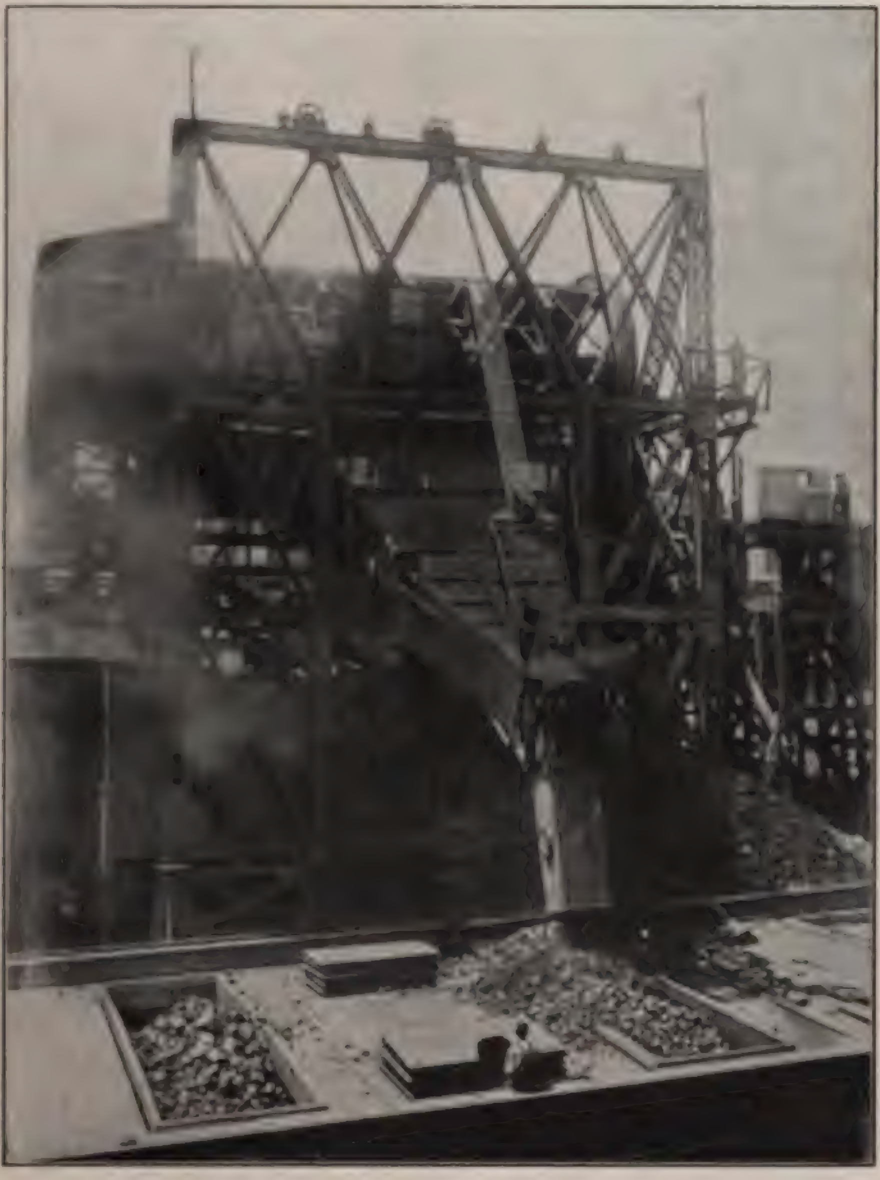
From Mr. John Stovering, it was learned that the first revolving crane was built by Lyman for Mr. Thomas Axworthy, and it was used on the Cleveland docks in 1875 and 1876. The next crane was built for David Barnheisel, and was placed on the Massillon Fuel Company's docks at Cleveland during 1876 and 1877. This machine was operated by Mr. Long, who afterwards designed the Long Car Dumping Machine. The next year three more derricks were built by the Excelsior



VIEW OF CRADLE OF A LONG CAR DUMPER.
This machine was built by the Excelsior Iron Works, Cleveland, O.

Iron Co., for Mr. McMyler, to be used on the Cleveland docks. During that same year two more were built for the Toledo & Ohio Central railway at Toledo and for the Wheeling & Lake Erie railway to be used at Huron. These were all designed for one-ton buckets, and the loading of 400 tons in 12 hours was regarded as a good day's work.

During the summer of 1879 or 1880 one was installed at Lorain and others at Cleveland. All of these derricks handled buckets, which contained a ton of coal each. They were held in position by a catch attached



CHUTE AND HOISTING ARRANGEMENT OF THE LONG CAR DUMPER.

This machine is in daily use on the docks of the Erie R. R. Co., at Cleveland.

to the bale, and when the bucket was in a position to be emptied, the engineer pulled a rope, liberating the latch and the bucket tipped of its own weight. This reduced the price of loading from 20 to 18 cents per ton. To economize further the size of the buckets was increased until 1892, when the standard bucket was made to hold five tons of coal.

During the summer of 1890, the Ludlow bucket, with the drop bottom, was brought into use, which permitted the coal to be lowered near

THE McMYLER COAL HANDLING MACHINE.

In this machine coal is dropped from bottom of car into bins and thence by belt conveyor and chute to the hold of the vessel.

the bottom of the vessel, thus saving a great deal of breakage. This, and the increased size of the bucket reduced the price to about 15 cents per ton. The revolving derrick remained the modern unloading machine until during 1890, when the Lindsley Car Dumping machine was put into service on the docks of the Cleveland, Canton and Southern railway at Cleveland. This was designed by Edward Lindsley in 1889 or 1890. It is the pioneer of the 15 machines now located at the several lake ports. The plan consisted of an elevated cylinder, into which the loaded car was

drawn, and from which it was lowered by means of a cable over an incline, attached to the end. The car was then clamped, and revolving the cylinder it emptied the coal into a chute to which was attached a telescopic spout, which extended into the hatch of the vessel. This machine cost $45,000, and has a record of emptying 125 cars in 12 hours. The location was not an ideal one, which necessitated many alterations in the original plans, and, as a result, it met with some unfortunate changes. It was also found to lack sufficient strength in some parts, partially due, no doubt, to the increased size of the railroad cars that were brought

McMYLER BELT CONVEYOR MACHINE.

into use pending its construction. At the time of its construction, the average cars in service were 20,000 to 40,000 lbs. capacity, but the railroads began to rapidly change to 60,000 and 100,000 lbs. cars, but 50,000 lb. cars were handled with difficulty.

Care was taken to keep a constant stream of coal from the car to the hold of the vessel in order to avoid breakage.

Coal was handled at a cost of 14 cents per ton with additional 3

[illegible]

THORNBURG MACHINE, DUMPING THE CAR.

cents for loading and trimming.

It had the opposition and prejudice of many shippers of coal and vessel owners, and perhaps some opposition from labor, and, although it has been since removed, it was by no means a failure, as some people seemed to think. It will be seen that other designers profited by Mr. Lindsley's experience, as they have imitated many of his valuable ideas.

The second unloading machine was the McMyler End Dump, designed by Mr. G. H. Hullett, and first used on the Lake Shore and Michigan Southern docks at Ashtabula in June of 1895. This machine may be described as a traveling cantilever crane. It is supported by a pivot, which travels on a line of railway track paralleling the dock. On the tracks that support the pivot there is constructed an engine for drawing the car up an incline, and when it has passed the center the car and the trunnion are inclined by the aid of a hydraulic ram to such an angle as to discharge the coal into a pan and then through a telescopic chute into the bottom of the vessel, the railroad having equipped 2,000 of their cars in such a way that the end gate could be raised to allow the coal to pass out. When the car is emptied, the trunnion is reversed and the car is discharged. The machine is then moved along to opposite another track, as well as the next hatch, thus allowing the trimming to be done in the first one. This operation is repeated until the boat is loaded. By thus shifting the discharge of the coal the boat is able to maintain an even keel. Neither is it strained and the expense incident to its being moved is omitted. This machine cost $30,000 and has a capacity of about 12 cars an hour. It required four men at an expense of about $10 a day to operate it. The rapidity of loading with the end dump machine at Ashtabula was the means of inducing the larger boats while clearing from Buffalo to stop and load with coal. Owing to the slight delay the operators secured a reduction in the freight rates of five cents per ton. It is said that this was the first instance where the large boats could be induced to stop on their way up the lakes.

Another machine built by the McMyler people, which was a duplicate of the above was erected at Fairport harbor during the summer of 1895. It was built to work with greater rapidity, and has been able to handle 15 cars an hour. The Pittsburg and Western Railway Company arranged 2,000 of their cars to be operated in this trade. The machine cost $45,000, and requires the same amount of help to operate it as the former.

The next machine was the invention of Mr. Timothy Long, and was built by the Excelsior Iron Works of Cleveland, for the Erie Railroad. It went into service in September of 1895. This machine is provided

with a cylinder 40 feet in length and of such a diameter as to receive a railway car, which is pushed in by a switch engine. Four automatic clamps hold the car in place. One stroke of the cylinder causes the car cylinder to roll up an incline plane, to which two automatic spouts are attached. When the coal first leaves the car the pan stands horizontally,

McMYLER CO.'S "PAN" MACHINE.

The vessel is a "whale back" and is generally towed by a propeller.

which prevents the coal from sliding down the spouts with great rapidity. After the spouts are once filled with coal the breakage is greatly reduced, as the pan is kept filled with coal while the loading continues. The stability, simplicity and speed and the cost of operating it is at least the equal of any machine yet introduced. It cost $25,000, and the first afternoon it started unloaded 64 cars. It has a record of 24 cars in 29 minutes. Its best record was while loading two vessels, when it dumped 176 cars in eight and one-fourth hours. During the season of 1898, between the 18th of March and the 16th of December, during which time there was lost on an average a day a week, this machine loaded over 800,000 tons of coal. Four men are required to operate it, one engineer to operate the cylinder, one fireman and the two chute tenders.

The fifth installation of car dumping machines, really the fourth in design, was built by the McMyler Company for the Cuddy-Mullen Company during the summer of 1899. This was the side dumping machine, the car being pushed on a bridge, and thus hoisted vertically to the heighth of the chute, where it was turned over on its side, the coal falling

McMYLER HIGH LIFT CAR DUMPER

The coal is only disturbed the one time

inside the chute, from which through a telescopic spout, it passed into the vessel. This was the result of designs and patents of Messrs. Clarkson, Hullet & McMyler. The average daily capacity of this machine is from 6,000 to 7,000 tons and the maximum capacity is 8,500 tons during 24 hours. This machine worked without friction from the start and loaded 500,000 tons of coal during the first year of its existence. The original cost was about $35,000. It was constructed with a view of handling cars carrying 35 tons. Four men were required to operate it. During the year of 1898, it was rebuilt so as to enable them to handle the

LATEST MCMYLER MACHINE, SHOWING SCREENS.

Screenings are carried to left of machine by a screw conveyor and thence into bins.

50-ton steel cars, and the machine is said to be strictly up to date. This plant is located on the Lake Shore, on the outer harbor, for which it is claimed to have an advantage over the other Cleveland plants inasmuch as it avoids the towing of vessels up the river, and also permits the coaling of the largest vessels of the lake with the least possible delay.

During the summer of 1897, the McMyler Company erected a second plant on the docks of the Valley railroad, which, with the exception of a few changes, was a duplicate of the one above described.

HULETT CAR DUMPER, HANDLING ORE AT FURNACES

First machine ever built for this purpose

A later machine was designed by the McMyler Company during 1898, when two were built, one of which was erected at Conneaut and the other at Lorain, in both of which the side dumping principle is retained, but instead of hoisting the bridge and car as before, the cradle remains stationary, being hinged at one side, and the car is turned over, emptying its contents into a pan having a capacity of from 40 to 50 tons. This pan is raised to the elevation of the chutes, the outer side being gradually raised until the coal passes inside the chute and through the

telescopes into the vessel. The telescopic arrangement, however, is improved by the use of a door which regulates the flow of the coal. These machines have a capacity of about 20 cars an hour, and cost about $45,000 each. Four men are required to operate each machine.

The McMyler Co. built a side dump machine for the Delaware, Lackawanna & Western R. R. Co. at Hoboken, N. J., for handling anthracite coal.

HULETT PORTABLE CAR DUMPER FOR HANDLING ORE

This machine is equipped with screens and all matter that goes through, drops onto a screw conveyor which transfers the coal by means of bucket conveyor to a hopper, high enough to dump to a car.

This was the first machine built on the coast and the first to handle anthracite coal extensively.

The first application of the dumper to cars carrying ore to blast

furnaces was originated by Mr. G. H. Hullett and built and installed by Webster, Camp & Lane, at Youngstown in 1890.

This machine dumped the ore into pits from which it was conveyed by buckets on bridges either to stock pile or to furnace cars.

This machine was built for 50 ton cars and handled 1,000,000 tons of ore in 7 months.

This method is considered more economical and satisfactory than any other.

The next was the movable car dumper designed by the above gentlemen and built by The Wellman-Seaver-Morgan Co. and installed at Johnstown, Pa., for the Cambria Steel Co.

This machine requires the services of only one man beside the railway crew and will handle 120 cars per day.

LOCOMOTIVE BUILT BY THE AMERICAN LOCOMOTIVE CO., NEW YORK.

TRACTIVE FORCE AND HAULING POWER.

THIS article is written with a view of relieving, if possible, some of the haziness that exists in the minds of so many contractors and locomotive engineers as to the real meaning of the terms "tractive force" and "hauling power."

The subject will be confined largely to small locomotives, such as contractors' "dinkies" and to locomotive cranes. In these the element of speed does not enter into the discussion to any great extent.

The tractive force, and from it, the hauling power of a locomotive of any kind, be it steam, electric or air driven, is the real measure of its usefulness, and hence is of prime importance in its design and construction.

These terms are often used synonymously, whereas, in fact, they really mean two very different things. The tractive force of a locomotive is the pulling force that it exerts at the draw bar and is an inherent part of the locomotive, that is, is determined by factors within the engine itself, and is not effected by any external conditions, such as the track, number of cars, etc.

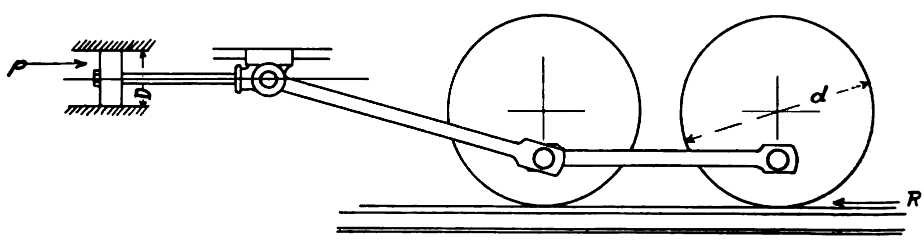
The hauling power is a certain per cent of the tractive force and depends upon the road bed, the cars, the speed and other conditions. It is determined by dividing the tractive force by the total resistance caused by these factors.

A locomotive may be compared to a stationary engine by considering the driving wheels as taking the place of the ordinary pulley flywheel and the rails the place of the belt. Then the tractive force is the power the engine delivers at the circumference of the drivers to the rails, in the same manner as the power is delivered by the stationary engine to the machine it is running, which is less than that at the flywheel by a certain per cent due to the friction losses.

The formula used to obtain this is:

$$T = \frac{D^2 \times .85\, p \times S}{d} \qquad (1)$$

and is derived as follows:



Let:
W=work done,
R=resistance overcome,
T=tractive force in pounds,
P=rotative force acting on the driving wheel,
p=boiler or gage pressure in pounds per square inch,
D=diameter of cylinder in inches,
S=stroke of engine in inches,
d=diameter of driving wheel in inches.
and the engine be considered as making one complete stroke or revolution.

Then the force tending to rotate the driving wheel on its axles is the product of the area of the piston in square inches multiplied by the steam pressure per square inch multiplied by the distance through which it acts (or twice the stroke of the engine). Put into a formula, this becomes:

$$P = \frac{\pi D^2}{4} \times p \times 2S \qquad (2)$$

Again, the work done is equal to the resistance overcome multiplied by the distance through which it acts, or the resistance the train offers to being moved multiplied by the distance it is moved during one revolution of the driver, from which we have

$$W = R \times \pi d \qquad (3)$$

It is very evident that the power exerted, and the work done, must be equal to each other and also that the resistance overcome is equal to the tractive force. Therefore, substituting "T" for "R" in (3) and equating (2) and (3) we have

$$T \times \pi d = \frac{\pi D^2}{4} \times p \times 2S \qquad (4)$$

or solving for "T" gives

$$T = \frac{\pi D^2}{4} \times p \times 2S \times \frac{1}{\pi d} = \frac{D^2 \times p \times S}{2d} \qquad (5)$$

When we remember that a locomotive has two cylinders, we can cancel the 2 in (5) making the formula read

$$T = \frac{D^2 \times p \times S}{d} \qquad (6)$$

CONTRACTOR'S "DINKEY" WITH DUMP CARS.

Built by the Vulcan Iron Works, Wilkesbarre, Pa.

Thus we see that the tractive force of a given engine depends entirely upon the steam pressure, the diameter and stroke of the engine, and the size of the driving wheels. In the case of a geared locomotive, such as a locomotive crane or a Shay locomotive, the size of the driving wheels will be effected by the ratio of the gearing, as will be explained later.

In (6) the factors "D," "S" and "d" are always constant for a given locomotive, leaving "p" as the variable member. In the class of machines under discussion, where the speed seldom exceeds ten miles per hour, and where the ordinary ratio of cut-off is $\frac{3}{4}$ or $\frac{7}{8}$ stroke, we can take the steam pressure at the cylinder as being 85% of the boiler or gage pressure.

Formula (6) then becomes

$$T = \frac{D^2 \times .85p \times S}{d} \qquad (7)$$

This is the theoretical value for the tractive force, but in practice it must be still further reduced, owing to the internal friction of the various parts of the locomotive, by multiplying the theoretical tractive force by the efficiency of the locomotive.

For the ordinary contractors' locomotive, the efficiency may be taken as 92%, thus making the final formula for tractive force

$$T = \frac{D^2 \times .85p \times S}{d} \times .92 \qquad (8)$$

An inspection of the formula will show, by the position of "d," why large freight and switch engines are made with small driving wheels in order to obtain great tractive power and why passenger engines, where speed is one of the major considerations, have comparatively large ones.

Locomotive builders compare engines by the tractive power developed per pound of effective steam pressure per square inch on the pistons or

$$T = \frac{D^2 \times S}{d} \qquad (9)$$

thus eliminating the variable factor entirely.

In order to realize the maximum tractive force the locomotive must be correctly designed so that it will have sufficient weight on the drivers to utilize the full force of the cylinder power. If the engine is too light, the wheels will "skid" or slip around on the track, while, if it is too heavy, there will be just that much extra dead weight to be moved. The ratio of weight to tractive force varies according to the use to which a locomotive is to be put and as experience has shown to give the best results.

In our class of contractors' locomotives the weight on the drivers is generally made about five or six times the calculated tractive force, this weight being required owing to the bad conditions of track and equipment, usual and unavoidable where they are used.

To illustrate the use of the above formula, let us take an example as follows:

What is the tractive force of a contractors' "dinkie" locomotive having the following specifications: Engines 8"x14"; Driving wheels, four 28" diameter; Boiler pressure 140 pounds per square inch; Working weight on drivers 21,000 pounds. Saddle tank type, no tender?

Substituting in (8) we have

$$T = \frac{8 \times 8 \times .85 \times 140 \times 14}{28} \times .92 = 3503 \text{ pounds.}$$

This gives a ratio between working weight and tractive force of six to one, which agrees very well with the usual practice.

In the case of a locomotive crane where the wheels are driven by gearing instead of being directly coupled to the engine, we must first find the effective diameter of the drivers. Taking a 10 ton crane as an example, we may figure the tractive force as follows: In order to make the arrangement clear, reference will be made to Fig. 2, which shows, diagramatically, the arrangement of the engines, gearing, etc. of the driving mechanism.

The effective diameter of the drivers is

$$\frac{26}{28} \times \frac{20}{32} \times \frac{17}{32} \times 28 = 8.63$$

CONTRACTOR'S LOCOMOTIVE.

Built by H. K. Porter Co., Pittsburg, Pa. 36" gauge, 10x16 cylinders, 37" driving wheels, 150 lbs. steam pressure, 56,000 lbs. working weight.

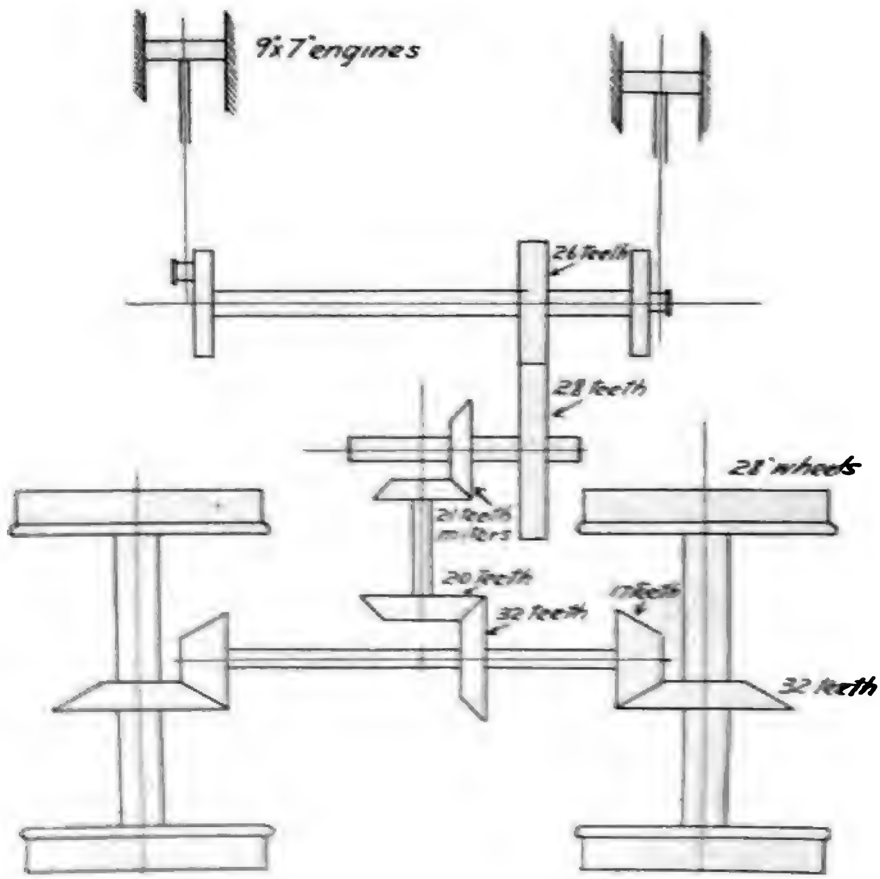


FIG. 2

The specifications of the crane are: Engines 9"×7"; Driving wheels 8.63" effective diameter; Boiler pressure 100 pounds per square inch; Working weight 58,000 pounds. Owing to the number of gears used, we could not expect over about 83% efficiency at the wheels. Therefore, tractive force becomes, by (8)

$$T = \frac{9 \times 9 \times .85 \times 100 \times 7}{8.63} \times .83 = 4635 \text{ pounds.}$$

In this case the ratio of working weight to tractive force is over twelve to one. This is necessary because the body of the crane has to be made very heavy in order to lift the rated loads at the end of the boom.

Coming now to the hauling power. As noted at the beginning, this is the quotient obtained by dividing the tractive force, as found above, by

the resistance due to friction and other causes. The gross hauling capacity thus found must be reduced by subtracting the weight of the engine and tender from the result to get the net capacity.

This, then, can be stated as

$$H = \frac{T}{R} \tag{10}$$

where

H=hauling capacity in tons,

T=tractive force in pounds,

R=total resistance in pounds per ton,

The resistance in pounds per ton to the engine is controlled by many conditions, which may be noted as follows: (a) Condition of rolling stock; (b) Condition of track; (c) Curves; (d) Grades; (e) Character of the train and load; (f) Speed.

Taking these in order:

(a) Condition of rolling stock. This includes journal friction, flange and wheel friction on the track, and alignment of the trucks. When journals are kept well lubricated and cars are cared for as they should be, the resistance under this heading should not be over 2.5 to 5 pounds per ton, even with the small dump cars used in contract work.

(b) Condition of track. This is the source of the greatest loss to the contractors' locomotive, as, of necessity, the tracks must usually be laid with as little expense and time as possible, and must be in a condition to be easily and rapidly shifted from place to place as desired.

On a well laid permanent track the resistance should not exceed 2.5 to 5 pounds, making the total resistance due to (a) and (b) together average from 5 to 10 pounds per ton. But even the contractor who takes good care of his cars and track has usually to figure on a resistance as high as 25 to 30 pounds, while it may run as high as 50 or 60 pounds, if he is not careful of his machines.

(c) Curves. The resistance due to curves in the track varies so greatly with the sharpness of the curve, the length of wheel base of the engine and cars, and the gage of the track, that no exact formula can be given for calculating it.

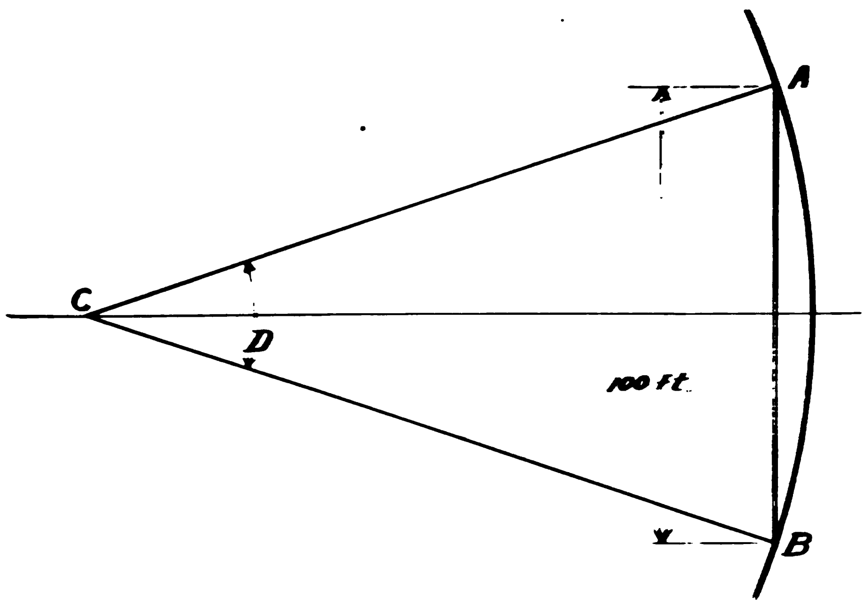
According to Mr. Geo. R. Henderson, however, the empirical formula

$$R_c = 0.5C$$

where C is the number of degrees in the curve, gives results practically correct for ordinary cases.

The civil engineer's method of designating a curve is by "degrees." This means the number of degrees contained in the angle formed by the

radial lines drawn from each end of a 100 foot chord of the curve, to the center, as shown in Fig. 3



where the chord A-B is 100 feet long, and C is the center of the curve. Then if the angle D is 10 degrees, the curve would be known as a 10 degree curve.

In a 1 degree curve the radius of the center line of the track is almost exactly 5,730 feet long, so if the radius of any curve is known, its measure in degrees can be easily found by dividing 5,730 by the known radius. The answer will be the degree of the curve. Thus, what is the degree of a curve having a radius of [illegible] feet?

$$\frac{5730}{[illegible]} = [illegible] \text{ degrees}$$

For the contractors' railroad with its sharp, rough curves, the formula (11) had, perhaps, better be taken as

$$[illegible] \qquad (12)$$

(d) Grades. The resistance due to grades is more readily calculated than the others, as it is due only to the force of gravity acting on the load (including, of course, the weight of the cars). Grades are designated in several ways, the two most in use being the railroad method of the number of feet rise in a mile, and the civil engineer's method of per cent, or the number of feet rise in 100 feet.

The resistance in pounds per ton in the first method is

$$2000 \times \frac{1}{5280} = 0.3788, \text{ or } R_G = 0.38G. \qquad (13)$$

where G is the rise in feet per mile.

In the second method the force of gravity per ton is always in direct proportion to the steepness of the grade. For a one per cent grade, it would be calculated thus,

$$R : 2000 :: 1 : 100, \text{ or } R = 20.$$

For a 2 per cent grade

$$R : 2000 :: 2 : 100, \text{ or } R = 40.$$

From this we see that the resistance in pounds per ton for any grade given in per cent, can be found from

$$R_G = 20G \qquad (14)$$

(e) Character of the train and load. By this is meant the kind of cars and the load they carry. It is obvious that box cars would offer more resistance to the air than flat cars, and that a train of flat and box cars distributed promiscuously would pull harder than one where the box cars were grouped together, since, in the latter case, each car would protect the one immediately behind it, while in the former, each box car would present almost its entire end to the wind. (See Note.)

This resistance is so extremely variable, however, that it cannot be dealt with in an article of this kind. Further, the contractors' cars are so small that the air resistance can be safely neglected.

(f) Speed. As in (e) the effect of this resistance will be disregarded, but a method of calculating it may be of interest. Numerous formula for the resistance due to speed have been put forth, a safe one of which is

$$R_s = \frac{S}{4} + 4. \qquad (16)$$

where S is the speed in miles per hour.

Returning again to formula (10) we must first of all calculate "R" (considering that we have already found a value for "T"). This must be made up of all the various individual resistances, or

$$R = (\text{value found by})\ a + b + c + d + e + f. \qquad (16)$$

Suppose now we calculate the number of loaded dump cars that the engine we used before could reasonably be expected to haul. Let the cars be 2 cubic yard capacity, in good condition and weighing 2,600 pounds each when empty. They are loaded with gravel weighing 2,700 pounds per cubic yard, and the track is in fair condition, offering a resistance, together with the car resistance, of 25 pounds per ton. Cars must be hauled up a grade of 2.5 per cent and around a 30 degree curve. The

CONTRACTOR'S "DINKEY" LOCOMOTIVE, HAULING DUMP CARS.

Built by the H. K. Porter Company, Pittsburg, Pa.

speed need not exceed 6 miles per hour. The weight of the engine is as given, 21,000 pounds, or 10.5 tons.

First, we must find R. According to the problem the track and car resistance, R, is 25 pounds.

For the grade we have by (14)

$$R_G = 20\ G = 20 \times 2.5 = 50 \text{ pounds.}$$

For the curve we have by (12)

$$R_C = .9C = .9 \times 30 = 27 \text{ pounds.}$$

Hence the total $R=25+50+27=102$ pounds per ton.

Then for the hauling capacity we have

$$H = \frac{T}{R} = \frac{3500}{102} = 34.3 \text{ gross tons.}$$

Deducting the weight of the engine, we have

$34.3-10.5=23.8$ or, say, 24 tons as the net load that can be hauled.

The cars, when fully loaded, will weigh 8,000 pounds, or 4 tons each, so, dividing the hauling power of the engine as just found by the loaded weight of each car we have

$$\frac{24}{4} = 6 \text{ cars.}$$

that the given engine can haul under the stated conditions.

According to the H. K. Porter Company's publication, *Light Locomotives*, the following tables may be used for the rapid calculation of the approximate hauling power of a locomotive on a level track.

For passenger, freight and industrial tracks, where both cars and tracks are kept in first-class condition, the average resistance may be taken as 6.5 pounds per ton.

For passenger, freight, logging and coal roads, where reasonably good care is taken, and the cars are of the best construction, an average of 8 pounds per ton may be used.

For industrial, logging, coal and ore roads and the like, where the track is somewhat poor, and the cars not of the best construction or not in thoroughly good order, an average of 15 pounds per ton may be used.

For railroad contractors, coal and ore roads, where cars with loose wheels, but otherwise in good condition, are used, logging roads and similar places, where four-wheeled cars of poor design are used, a fractional resistance of 30 pounds may be assumed. As a rule, however, a

resistance as high as this denotes a reasonable lack of care of tracks and cars.

[NOTE.—Under resistance (c) it should be further stated that the resistance varies according to the kind and condition of the load carried by the cars. If the load is very heavy for its bulk, as wet sand, iron ore, etc., the resistance per ton due to it will not be as high as it would for some light, bulky material, such as lumber.

This will be clearly seen by noting the fact that a given weight of lumber would present very much more surface for wind pressure than would a ton of iron ore.

Again, if equal amounts of lumber be loaded in a box car and on a flat car, the flat car load will offer more extra resistance to the air than that in the box car, as no additional surface is presented by the load in the box car over that already presented by the car itself.

The G in formula (14) represents the rise in feet per hundred feet of the grade, instead of the rise in feet per mile as in (13). In using the two formulæ care must be taken to assign the proper value to "G," according to the method used in stating the grade.]

BALDWIN LOCOMOTIVE

This locomotive is built by the Baldwin Locomotive Works, Philadelphia, Pa. 36" gauge, 9 x 14 cylinders, 28" driving wheels, 23,100 lbs. working weight.

RECENT DEVELOPMENTS IN ELECTRIC MINE HAULAGE.

SINCE 1887, when Schleisinger's aptly named "Pioneer" was built for the Pennsylvania Railroad, there has been a great advance in the design of small mining locomotives. While electric locomotives of various designs have been extensively used for the principal haulage work, it has been the general practice to gather the cars from the breasts and chambers of the mine by mules or horses. It is along this line that a new electric locomotive has been devolved, known as the gathering locomotive.

The cost of maintenance for mules and drivers vary with the accuracy of the bookkeeping, but may be placed at from \$2.50 to \$3.50 per day. Since the economy of electric haulage in mines has become so apparent,

FIG. 1. ELECTRIC MINE LOCOMOTIVE WITH CABLE REEL IN OPERATION.

there has arisen a need for an electric locomotive to meet the special requirements of the smaller traction work in rooms. It is not practicable to place a trolley wire along the room roads, and both the storage battery and compressed air locomotive have failed to fulfill the conditions; the first mentioned being ill adapted for rough mining usage, and the second, inefficient and restricted in range of action. A special arrangement of electric locomotives has been designed and works admirably under this service.

An example of such an arrangement on an electric locomotive is shown in Figs. 1, 2, 3. This machine weighs from four to seven tons, and is provided with a reel carrying about 600 feet of flexible insulated cable. On the main and butt entries of the mine the locomotive operates from the overhead trolley wire in the usual manner, but when entering a room, or chamber in hard coal terminalogy, the trolley pole is lowered and the end of the cable is attached to the trolley wire. The locomotive

FIG. 2. ELECTRIC MINE LOCOMOTIVE, SHOWING POSITION OF CABLE REEL.

then proceeds toward the face of the chamber (with the empty car), paying out the cable through which the current is supplied to the motors. On picking up its load, the cable is automatically rewound on the reel, which is now positively driven from the locomotive axle by a sprocket chain. Iron rails are generally used for room haulage today, but should wooden rails be in place, it is simply necessary to provide the locomotive with a double conductor cable instead of using the ordinary single conductor with rail return.

One of the most surprising features in regard to the operation of these cable reel devices is the long life of the cables. It might be expected that they would become abraided, but such is not the case, as the cable is carefully laid on the floor under moderate tension, and as carefully rewound. Owing to this improved reel winding mechanism, a flexible and well insulated cable may be expected to last a year in regular service before renewal is necessary.

Where heavy cars are used and severe grades prevail, the economy of these locomotives is greater than in more ordinary conditions. In other words, the more severe this service, the more favorable is the showing made by such a machine. Small cars are, however, generally employed in working low veins, and here the gathering locomotive has the advantage over its animal competitor in that it is unnecessary to "brush" the roof or take up the floor to make headroom for the mules. In the anthracite district, where the haulage conditions are particularly severe, these locomotives are regularly doing the work of ten to fifteen mules. A seven ton locomotive of this type has hauled loaded cars out of a dipping chamber where the grade was so steep that four mules in tandem were required to drag a single car. With the less severe conditions in the

FIG. 3. A LIGHT WEIGHT ELECTRIC MINE LOCOMOTIVE WITH CABLE REEL.

bituminous coal fields, experience has shown that a five ton electric gathering locomotive may be expected to displace from five to seven mules. The success and economy of this method of haulage is therefore seen to be a practical certainty.

The gathering capacity of the locomotive under ordinary conditions should be from 100 to 125 cars per day. Under unfavorable conditions, this may go as low as 50 to 60 cars per day, and where conditions are good, the output per locomotive may reach 150 cars. The average output per mule is from 30 to 40 cars, although under exceptionally favorable circumstances, this may reach 50 cars. In many mines, however, where grades are severe and string teams must be used, the output per mule often drops as low as 15 and 20 cars. When it is considered that the

average cost per mule per day is 50c, that each mule must have a driver, a great saving in the use of these locomotives is apparent.

Since the introduction of these gathering locomotives, there are a number of mines in Pennsylvania and West Virginia which have been opened, developed and operated wthout a mule in the mine.

In the use of larger locomotives for main haulage the tendency is toward the use of a locomotive of 10 to 12 tons, and, when additional power is required, two of such locomotives are operated in tandem, making a 20 or 24 ton locomotive. In some cases 8 ton locomotives are used in this way, and there are some in use as high as 14 tons in weight, each, making a total in locomotive of 28 tons.

With 50 or 60 lb. rails maintained in good condition, a 20-ton four-wheel locomotive is entirely practicable and has the important advantage of simplicity. Where the rails are light, however, and it is necessary to distribute the weight over a longer wheel-base, a different design is essential. Six wheel locomotives weighing twenty tons have been built, but because of the long rigid wheel base and practical operating difficulties, they are open to serious objections. The tandem locomotive, on the other hand, has a short rigid base in each unit and can, therefore, suc-

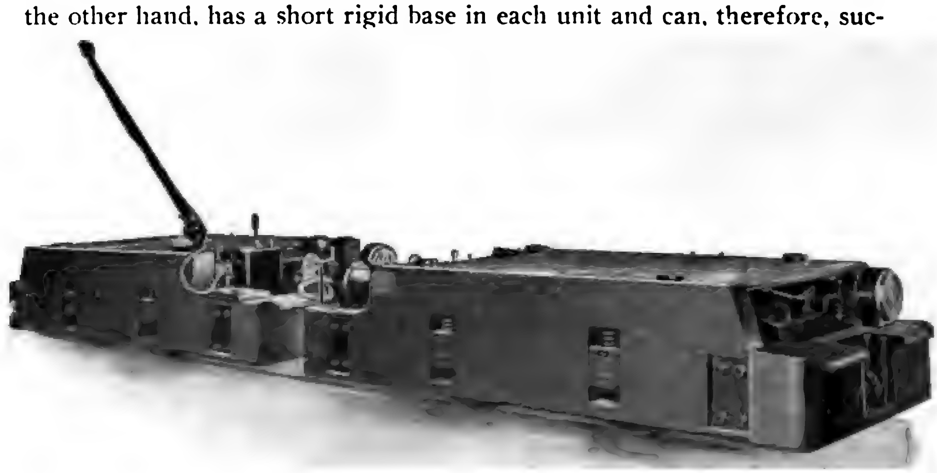


FIG. 4. ELECTRIC TANDEM MINE LOCOMOTIVE.

cessfully negotiate sharp curves. The weight is perfectly distributed on the four pairs of driving wheels and there is no tendency to overload any of the motors. As a consequence the wear and tear on the track will be less. In addition to this either of its units may, in emergency, be operated singly. The locomotive shown in Fig. 3 consists of two ten-ton locomo-

tives coupled mechanically and electrically. One of the machines is equipped with a four-motor controller, in the reversing cylinder of which is incorporated a commutating switch so that the locomotive may be operated in either direction with the four motors in parallel or in series-parallel. This method of control effects a considerable economy in the current consumption, since with the four motors in series-parallel the locomotive will develop a given draw-bar pull with half the current that is required with the motors all in parallel. The brake mechanism on this locomotive is arranged so as to apply the brakes simultaneously on each of the eight drives. In a coal mine with a large output these locomotives are advantageously employed to haul coal from side tracks where the cars have been previously assembled by gathering locomotives.

Turning now to the method of distributing the current, recently a three-wire system has been applied to mine haulage. In the anthracite field 275 volts is the customary potential for electric haulage, but the low voltage often involves high line losses, especially in view of the fact that the electric hoists on the slopes are operated from the same conduit. Many

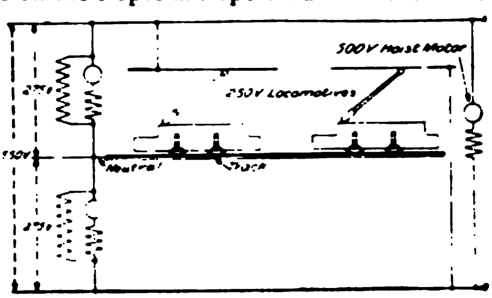


FIG 5. METHOD OF DISTRIBUTING CURRENT.
For 250 V locomotives from a 550 V circuit

such hoists require 150 horsepower or more and are often located at considerable distances from the power source so that a prohibitive investment in feeder copper would be required to secure a low line drop in a two wire line. This problem has been satisfactorily solved by adopting the three-wire system in the manner shown in Fig. 4. Two 275-volt electric generators are operated in series with the neutral acting as the track return. The 250-volt electric mining locomotives are operated on each side of the three wire system, while the hoist motors are operated across the 550-volt circuit as shown. This system of distribution, while permitting the use of 250 volts for locomotive operation, secures also the advantages of 550 volt transmission for the hoists.

Editor's Note.—The above article was written by a staff correspondent. Photograph used in Fig 1 shows a Jeffrey Mfg. Co.'s locomotive. Photographs and cuts used in Figs. 2 and 4 were furnished by the General Electric Co. Fig 3 by Goodman Mfg. Co. and data by G. R. Wood, Pittsburg.

GENERAL NEWS.

EXCAVATIONS AND FILLS ON A BELT LINE.

A belt line is being constructed around Cleveland, and work is progressing rapidly at several places. Mr. John Marsch has the general contract, and sections have been sublet to various contractors.

In crossing the country south and west of the city, many deep ravines must be either filled or bridged.

Mr. W. F. Carey has the contract to fill a ravine approximately 1,000 feet across on the road level and 200 feet deep at the greatest depth.

This fill will require about one million yards of dirt, and it will take nearly a year to do the work.

Two steam shovels are hard at work loading side dump cars, which are pushed to the base of the fill and unloaded.

One shovel, a 40 ton Bucyrus, is located at the side of a natural knoll of earth, which will be taken off clean with the base of the fill.

65-TON BUCYRUS SHOVEL LOADING DUMP CARS.

The other shovel, a 65 ton Bucyrus, is digging into the side of a hill back from the location of the fill.

Since the natural slope of the earth on embankments is about 1.3 to 1, it will be seen that the base of the fill will contain an area on which a large force can work easily.

It is estimated that this fill will cost $150,000 more than a bridge, but the permanent nature of it will offset the extra cost.

The Newburg & South Shore R. R. put in a spur west of the Brecksville road on which the machinery and supplies were transported.

The shovels were let down the hill at an angle of 45° to their present level by means of cables and winches, and the coal carried in baskets to enable the men to get a start. Chutes are being built to carry coal to a level to deposit into the dump cars, which are handled by dinkey locomotives of narrow gauge.

The illustration given shows the 65 ton shovel at work, with side dump cars and "dinkey" locomotive.

The Shaw Electric Crane Co., of Muskegon, Mich., has a government contract for eight wharf cranes for unloading supplies and material from ships for use in the construction of the Panama Canal. They are to be of special design, composed of a derrick mounted on trucks, and capable of self-propulsion along a track on the wharf. The derrick carries a balancing arm or boom which extends out over the ship, and upon which a trolley for carrying the load is mounted. The capacity of the cranes is eight tons each.

The Parsons Steam Excavator Co., Newton, Iowa, has recently completed an improved and practical steam shovel for the People's Construction Co., of Davenport, Iowa.

The Columbia Wagon Co., Columbia, Pa., is making extensive additions to its blacksmith shop and warehouse, as well as spending a great deal of money on new machinery. They expect this new improvement when completed to enable them to increase their capacity one-third over this year, which is the very best year they have had.

A sight of particular interest is the monster grab system at the Grant mine of the Jones & Laughlin Steel Co. This is the largest ore stripping and hoisting apparatus of its kind ever devised, and if the results of its operation are as successful as anticipated similar installations are expected to be made at other properties on the Mesabi. The plant has been constructed with two towers, each about 175 feet high and 1,150 feet apart, between which stretch heavy lock cable wire ropes. The grab, which weighs about 30 tons, will carry approximately twenty tons of ore or twenty yards of gravel at a load. It is operated on four trucks, each of which is provided with four wheels that run on four 2½ inch cables. As designed, the grab will pick up its load of ore or earth as the case may be, will raise it to the proper height, convey it the specified distance and drop it into the waiting car, the entire operation being calculated to consume two minutes. The towers are erected on tracks, and thus may be moved as occasion demands. The system is operated by electrical power.

Trench Shovel or Back Action Excavator.

This type of steam shovel is rather a unique piece of machinery in that it stands upon the solid ground at the end of the trench and digs towards itself.

After the dipper is filled and raised to the center of the crane, it may be swung and dumped on either side.

The dipper will raise and dump to a height of ten feet in the clear with the door open.

The machine is self-propelling and travels on heavy oak plank placed fore-and aft under the wheels whose tires are 12 in. wide.

The wheels are placed outside of car and so wide apart that the machine is not easily upset. Width of wheels, out to out, is 10 ft. 7 in.

The car is 28 ft. long by 7 ft. 7 in. wide and is built of heavy channels and beams with a steel plate floor.

[illegible] wheels 54 in. diameter, [illegible]

[illegible]

on the shipper shaft at the point of crane with hoisting chain 7/8 in. diameter.

The boiler is upright, 54 in. diameter, 7 ft. 6 in. high, with 137 tubes 2 1/2 in. diameter.

The great advantage in operating the machine on solid ground is that it leaves the trench open and free, also prevents caving in by relieving the bank of its weight.

This machine may be used as an ordinary steam shovel by removing the back-acting crane and substituting a regular go-ahead crane and dipper.

The shovel was first used by T. A. [illegible] in Allegheny, Pa., for excavating a large ditch and was highly successful. Several others have been sold [illegible] contractors.

[illegible] exclusively by the [illegible] Toledo, O.

[illegible]

SHOP PRACTICE.

iler Pressures in Locomotives.

has been pointed out by many who studied the subject that the life e boiler under the high pressures used is very much less than with a ly lower pressure; and that for this n, if for no other, such as econ- in both up-keep and repairs, as well the matter of keeping the engine mmission without the necessity of g it up for repairs, it would seem advisable to restrict the pressures, t for very special cases.

e adoption of high boiler pressures aturally led up to the introduction mpound engines; and this has ef- l a very considerable economy in consumption, which goes far to off- e destructive results brought about e high pressures. At the same time, s been pointed out that a pressure '5 pounds for simple engines and or compound ought to give all the s in the way of efficient working could reasonably be expected.

f. Goss, of Purdue, has been con- g experiments upon the effects of high pressures, and he has reached onclusion that any attempt to in- boiler pressures beyond those now would lead only to disappointment erative working results. Certain are possible, but these will be more neutralized by increased leakage, y an augmentation of the difficulties intenance and operation. He is l as of the opinion that even the unds, which is now accepted as the standard for modern practice, will be found finally to be too high for the best results, when it comes to a question of the balance sheet.

Friction Horse Power.

BY I. STAVAKOSKY AND M. A. PARKS.

From certain tests, which were recently made in a car shop, a cooper shop, a box factory and a machine shop, it was found that an average of about 60 per cent of the power developed by the engine is consumed in running the main shafts and belting.

In cases where light work is done and the machines well arranged with regard to the shafting probably 10 per cent less power could be allowed with safety, for friction horse power absorbed by shafting, belts, etc.

It is always economy to give especial care to the oiling of bearings, the adjusting of the same and proper alignment of all shafts. Pulleys of large diameters are counter shafts and narrow fast running belts also aid materially in the reduction of the friction horse power.

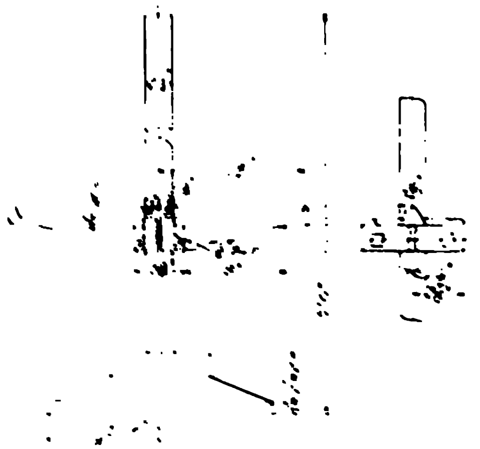
In locations where either the cost of fuel or water is high it might be well to guard against this excessive loss by friction by the installation of electrical transmission.

Racks for Pipe, etc.

The accompanying drawing shows a good form of standard for a pipe rack. Two or more of these standards may be used to form a rack according to the

length of the pipe to be held.

The standard consists of a pipe of suitable size and length screwed into a cast iron base. The supporting arms are made of cast iron. These arms are ad-



[illegible]

[illegible]

[illegible]

Speed and Power Transmission.

The factor of safety for a pulley may be greatly above the speed at which the belt will transmit power, owing to centrifugal force. At 5,250 feet per minute, laced leather belts transmit a maximum of power: and riveted belts at 6,325 feet per minute. Supposing a belt could be run safely at a speed of 9,250 feet per minute, it would transmit an amount of power scarcely appreciable, for the belt would lift from the pulley, leaving an air cushion between.

A Good Bearing Metal.

A mixture consisting of 50 per cent aluminum, 25 per cent. zinc and 25 per cent tin forms an alloy which is excellent as a bearing metal. It is light in weight, has a fair degree of hardness and a moderately high melting point.

A Good Gasket for Steam and Cylinder Heads.

[illegible] serviceable gasket may be [illegible] and cheaply by the following [illegible] heavy Manilla [illegible] paper should be [illegible] to the shape [illegible] and by the ordin- [illegible] gaskets. This [illegible] should then be soaked in boiled [illegible] few minutes and then [illegible] manganese mixture applied to it [illegible] must, the linseed oil mixing [illegible] the manganese mixture form a black [illegible] the surface. The gasket [illegible] while wet and will [illegible] and efficient [illegible] the pressures of steam [illegible]

Power for Windmills.

[illegible] as far as we can de- [illegible] been used for [illegible] how- [illegible] be reduced to [illegible] windmill with a twelve

le is commonly rated at two
er and one with a sixteen foot
rated at four horsepower. If
er were utilized for compress-
he results obtained would be as

rill compress 9.6 cu. ft. of free
min. to 100 lbs. gage.
rill compress 11 cu. ft. of free
min. to 80 lbs. gage.
rill compress 19 cu. ft. of free
min. to 100 lbs. gage.
rill compress 22. cu. ft. of free
min. to 80 lbs. gage.

ove results were calculated on
nption that 15 per cent be al-
r friction in the air compress-
ine, but probably for an appara-
his kind a greater allowance
made. As large a receiver as
should be used to take care of
nittent nature of the power sup-

ot practicable to use wind-power
eneration of electricity.

A Cape Cod Pump.

"DON BETA."

rosts and winter weather are
s to the year's crop of cran-
nless these destroying elements
come by flooding the bogs with
n the section referred to above,
ommonly done by opening the gates of an adjacent reservoir or pond and allowing the water to overflow the cranberry plant.

This is an easy matter, as the bog is level and has a series of irrigating ditches, the whole surrounded by an embankment for retaining the water. When the level of the bog is above the water level, it is necessary to pump this water and the design of the pump in general use is very simple yet the machine is very effective.

The driving shaft of the pump is vertical, and the pump itself is entirely submerged. The design and dimensions of the one which came under the writer's observation were as follows: Below the lower bearing and at the end of the vertical shaft was fastened the disc A, twenty-four inches in diameter, with the hub C projecting down to the end of the shaft as shown in Fig. 1. This disc was entirely surrounded by a circular drum eight inches deep, with the exception of the outlet D through which the water was forced.

To the lower part of the disc were fastened two blades E and E.' These were not placed radially but, being fastened to the hub which was about four and one-half inches in diameter, were brought over to one side of the center thus allowing no pocket in which the

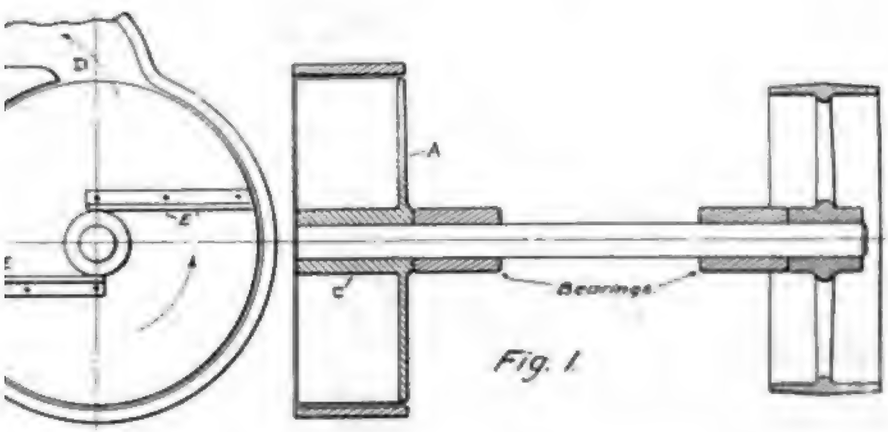


Fig. 1

water could be held. The arrow indicates the direction of rotation of the pump.

In Fig. 2 are shown two views of the blades which are fastened to the lower part of the disc. The small ledges at the bottom and on the end form a shallow scoop which forces the body of water along in front of it and does not allow much to escape below or around the end. The pump has a rectangular outlet eight by eighteen inches and when running 310 revolutions pumps about 3,200 gallons per minute. The lift is six feet.

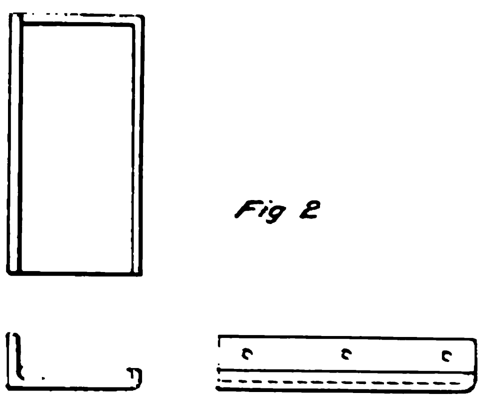


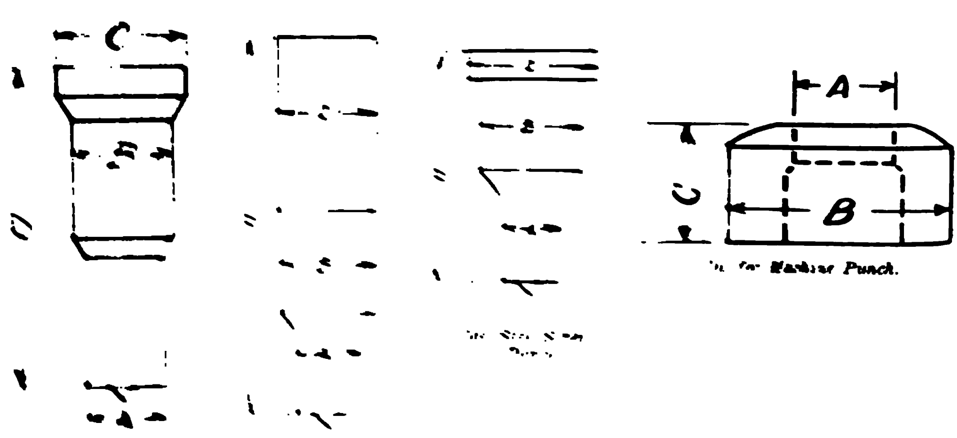
Fig 2

This particular pump was belted direct from a twenty horse power "Alamo" gas engine, it being necessary to use a quarter turn belt, as the pump spindle is vertical. The engine pulley is 28 inches in diameter, the pump pulley is 22 inches and the belt is 8 inches wide.

The air cylinder of an air compressor should be lubricated with the best grade of mineral oil of light body and high flash test. It should not be of a coking nature, for if it is, it carbonizes on the inside surfaces of the air heads and valves and not only prevents the valves from acting properly, but it frequently is the cause of accidents. The air cylinder requires but a small quantity of oil and after the machine has been running long enough for the cylinders to acquire smooth and polished surfaces, two or three drops per minute will be found a sufficient amount to keep the cylinder and its valves in satisfactory condition.—*Practical Engineer.*

How to Order Punches and Dies.

Owing to the difficulty we have at times, says Joseph Ryerson & Son, Chicago, Ill., experienced in ascertaining from orders the kind of punches desired by our customers, we give herewith a few suggestions, which, if followed, we believe will save considerable time and correspondence. The bother of sending in old and broken punches to be duplicated can also be done away with.



The illustration shown will easily enable one to determine by comparison whether the punch to be replaced is a machine punch or for a forged or cast steel screw punch. When ordering machine punches and dies, the number which appears on both punch and die should be given and the make of the machine in which they are to be used stated. In case the numbers cannot be found, it will be necessary to give the dimensions of both punch and die as designated by the letters, A, B and C and D.

When ordering screw punches and dies, it is necessary to state whether punch and die are for a forged or cast steel screw punch and to give the number of the tool. Dimensions referring to the above cuts will be sufficient in case the number of the tool is unknown. The only dimension to determine the die in this case is the diameter of the hole.

Making Small Core Boxes.

The making of small core boxes and other hollow pieces of wood that should be semi-circular in cross section is one of the many jobs in every shop. The hollow portion should be an exact half circle with its center on the edge of the piece of wood. Take another block and clamp together in the vise so that their end views appear, as in Fig. 1, and inscribe a semi-circle on the piece to be cut. Then draw lines along on top of the block the width of the semi-circle, and draw a semi-circle on the opposite end. If a table saw is at hand that can be raised and lowered, a series of cuts may be made lengthwise, as shown in Fig. 2.

If no saw is at hand, fasten the block securely in the vise and gouge out the wood down nearly to the circle, testing the work with the corner of the square, as shown in Fig. 4.

When we learn the great principle that any angle inscribed in a semi-circle is a right angle, we see that the corner of the square, being a right angle, will fit down in the hollow when it is a true semi-circle.

The box can thus be tested as the work proceeds, and when the material is cut out to the horizontal lines and the square just touches everywhere the box may then be sandpapered and shellaced.—*Practical Machinist.*

A short rule for finding the change required in the length of belt when one of the pulleys on which it runs is changed for one of different size, is as follows: Take three times the difference between the diameters of the pulleys and divide by two. The result will be the length of belt to cut out or put in.

Fig 1

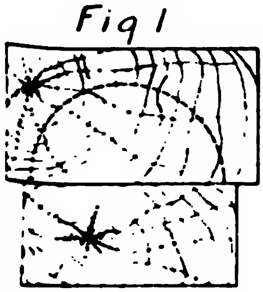
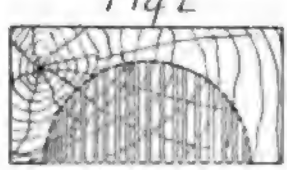
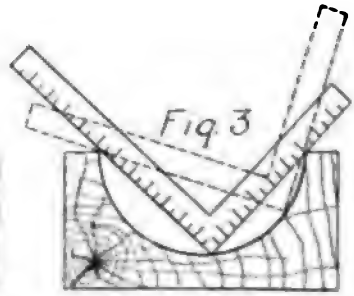


Fig 2





ENGINEERING DEPARTMENT

INCLUDING

DRAFTING ROOM PRACTICE.

The Art of Inventing.

BY EDWIN J. PRINDLE.

A most interesting example of the evolution of an invention is that of the cord-knotter of the self-binding harvester. The problem here was to devise a mechanism which would take place of the human hands in tying a knot in a cord whose ends had mechanically been brought together around a bundle of grain.

The first step was to select the knot which could be tied by the simplest motions. The knot which the inventor selected is that shown in Fig. 10, and is a form of bow-knot.

The problem was to find how this knot could be tied with the smallest number of fingers, making the smallest number of simple movements. As anyone would ordinarily tie even this simple knot, the movements would be so numerous and complex as to seem impossible of performance by mechanism. The inventor, by the study of his problem, found that this knot could be tied by the use of only two fingers of one hand, and by very simple movements. The knots will best be understood by following the motions of these fingers in tying the knot. Using the first and second fingers of the right hand, they are first swept outward and backward in a circular path against the two strands of the cord to be tied, shown in Fig. 1.

The fingers continue in their circular motion backward, so that the strands of the cord are wrapped around these fingers, as shown in Fig. 2.

Continuing their circular motion, the fingers approach the strands of the cord between the twisted portion and a part of the machine which holds the ends of the cord, and the fingers spread apart as shown in Fig. 3, so that they can pass over and grasp the strands thus approached, as shown in Fig. 4.

The fingers then draw back through the loop which has been formed about them, the fingers holding the grasped portion of the strands, as shown in Fig. 5.

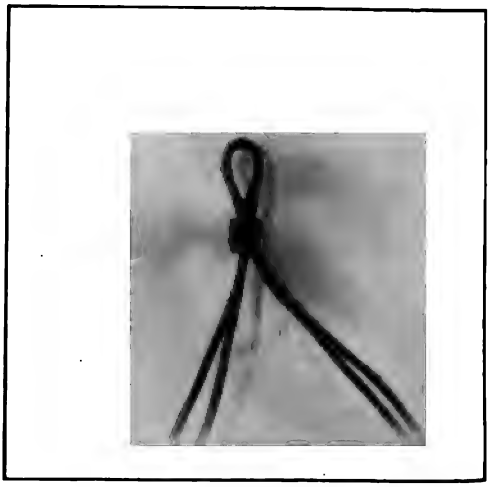


Fig. 6.

The knot is finished by the completion of the retracting movement of the fingers through the loop, thus forming the bow of the knot as shown in Fig. 6.

The inventor found that one finger could have a purely rotary movement, as if it were fixed on the arm and unable to

e independently of the arm, and the ement being as if the arm rotated a shaft, but the second finger must urther capable of moving toward from the first finger to perform the

Fig. 1

ing movement of Fig. 3, and the ng movement of Fig. 4 by which asps the cord. The inventor ac- ngly, from his exhaustive analysis s problem, and his invention or dis- ry of the proper finger motions, had er only to devise the very simple anical device illustrated in Fig. 17 place his fingers.

e index finger of the hand is rep- ted by the finger *S*, which is in- d with the shaft *V*. The second fin- of the hand is represented by the r *U*, which is pivoted to the first r by the pin *s*. The grasping move- of the finger *U* is accomplished by ring *V*'' bearing on the shank *U*', its opening movement is caused by ravel of an antifriction roll *U*'', on ear end of the pivoted finger, over n *V*''', on the bearing of the shaft. shaft is rotated by the turning of a pinion *W* on the shaft through the action of an intermittent gear. The necessity of drawing the fingers backward to accomplish the movement between Figs. 14 and 16 was avoided by causing the tied bundle to have a motion away from the fingers as it is expelled from the machine, the relative motion between the fingers and the knot being the same as if the fingers drew back.

Thus the accomplishment of a seemingly almost impossible function was rendered mechanically simple by an evolution from the human hand, after an exhaustive and ingenious analysis of the conditions involved.

It will be seen from the examples I have given that the constructive part of inventing consists of evolution, and it is the association of previously known elements in new relations (using the term elements in its broadest sense). The results of such new association may,

Fig. 2

themselves, be treated as elements of the next stage of development, but in the last analysis nothing is invented or created absolutely out of nothing.

It must also be apparent, that pure reason and method, while not taking the place of the inventive faculty, can clear

the way for the exericse of that faculty and very greatly reduce the demands upon it.

Where it is desired to make a broadly new invention on fundamentally different lines from those before—having first studied the art to find the results needed,

Fig. 3.

the qualities of the material or other absolutely controlling conditions should be exhaustively considered; but at the time of making the inventive effort, the details should be dismissed from the mind of how results already obtained in the art were gotten. One should endeavor to conceive how he would accomplish the desired result if he were attempting the problem before any one else had ever solved it. In other words, he should endeavor to provide himself with the idea elements on which the imagination will operate, but to dismiss from his mind as much as possible the old ways in which these elements have been associated, and thus leave his imagination free to associate them in original and, as it is hoped, better relations than before. He should invent all the means he can possibly invent to accomplish the desired result, and should then, before experimenting, go to the art to see whether or not these means have before been invented. He would probably find that some of the elements, at least, have been better worked out than he has worked them out. Of course, mechanical dictionaries, and other sources of mechanical elements and movements will be found useful in arriving at means for accomplishing certain of the motions, if the invention be a machine. Many important inventions have been made by persons whose occupation is wholly disconnected with the art in which they are inventing, because their minds were not prejudiced by what had already been done. While such an effort is likely to possess more originality than that on the part of a person in the art, there is, of course, less probability of its being thoroughly practical. The mind well stored with the old ways of solving the problem will, of course, be less likely to repeat

Fig. 4.

any of the mistakes of the earlier inventors, but it will also not be as apt to strike out on distinctly original lines. It is so full, already, of the old forms of association of the elements as to be less likely to think of associating them

ally new relations.

hing should be considered impos- until it has been conclusively d out or tried by experiments leave no room for doubt. It is no nt reason for believing a thing work because immemorial tradi- or those skilled in the art, say it ot work. Many an important im- nent has been condemned as im- able, by those in the art, before it en tried.

onception which an inventor has striving for unsuccessfully will mes come to him at a time of unac- ed mental stimulation. The slight ation of the movement of a train s, and the sound of music, have nown to produce this effect. The nscious mind, after having been ed by a full consideration of the m to be solved, will sometimes the problem without conscious ef- n the part of the inventor.

inventing a machine to operate ny given material, the logical way work from the tool to the power. ol or tools should first be invented, e motions determined which are given to them. The proper gearing ts to produce from the power each for each tool should then be in- l. It should then be considered if of each train of gearing cannot be ed, so as to make one part do the of a part in each train; in short, to the machine to its lowest terms. ionally a mechanism will be in- l which is exceedingly ingenious, hich it is afterwards seen how to fy, greatly at the expense of its nt ingenuity. This simplification at the sacrifice of the pride of the or, but such consideration as ess, durability and certainty of leave no choice in the matter. It ometimes be found that a single part can be made to actuate several parts, by the interposition of elements which reverse the motion taken from such part, or which take only a component of the motion of such part, or the resultant of the motion of such part and some other part. Where a machine involves the conjoint action of several forces, it can be more thoroughly studied, if it is found there are positions of the machine in which one force or motion only is in operation, the neglect of the others in such position being eliminated, and thus the elements making up the resultant effect can be intelligently controlled.

The drawing board can be made a great source of economy in producing inventions. If the three principal views of all the essentially different positions of the parts of a machine are drawn, it will often be found that defects will be brought to light which would not otherwise have been observed until the machine was put into the metal.

It is desirable to see the whole invention clearly in the mind before beginning to draw, but if that cannot be done, it is often of great assistance to draw what can be seen, and the clearer perception given by the study of the parts already drawn, assists the mind in the conception of the remaining parts.

If the improvement which it is sought to make is a process, it should first be considered whether any radically different process can be conceived of, and if so, whether or not it is better than the old process, and the reason for its defects, and whether it is possible to cure those defects. If the old process appears to be in the right general direction, it should be considered whether one of the old steps cannot with advantage be replaced by a new one, or whether the order of performing the steps cannot be changed to advantage. I have in mind one process in which a reversal of the order of steps resulted in giving the

product certain desirable qualities which had before been sought for, but could not be obtained.

It is sometimes desirable not only to invent a good process of producing a product, but to control all feasible processes of producing the product. Such a case occurred where the product itself had been patented, and it was desirable to extend the monopoly beyond the time when the patent on the product should expire. There were two steps or operations which were essential to the production of the product, and the inventor, by reference to permutations, saw that there were but three orders in which those steps could be performed; first, the order A-B, then the older B-A, and then both steps together. The order A-B was the old order, which did not produce an article having the desired qualities. The inventor therefore, proceeded to invent ways by which the steps could be performed together, and then by which they could be performed in the reverse order, and the patenting such two processes would cover generically all possible ways of making the article and secure the desired results of putting himself in position to control the monopoly after the patent on the article had expired, because no one could make the article without using one of his two processes.

Fig. 5.

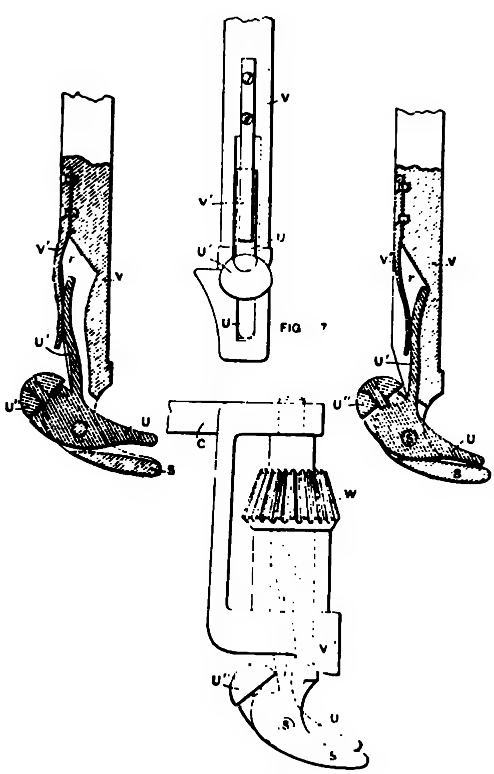


Fig. 7
The essential parts of the cord knotter.

In inventing compositions of matter there is one inventor who, if he is seeking for a certain result, will take a chemical dictionary and make every possible combination of every substance that could by any possibility be an ingredient of that which he desires to produce. It is as if he were seeking to locate a vein of mineral in a given territory, and, instead of observing the geographical and geological formation, and thus seeking to arrive at the most probable location of the vein, he should dig up every foot of earth throughout the whole territory, in order finally to locate the vein. This method is exceedingly exhaustive, but

not appeal to one as involving much ise of the inventive faculties.

venting has become so much of a ce, that if one is willing to spend ient time and money to enable a

Fig. 6

etent corps of inventors to go at the er exhaustively, almost any possible tion involving but a reasonable ad- e in the art can be perfected.

ocation of the Drafting Room.

"DRAFTSMAN."

his article may not change the lo- n of drafting rooms for shops al- y established, but is written with a to assist those who may, sooner later, be called upon to arrange a t and especially look after the rela- of the drawing room to the shop.

he first essentials are good light and d ventilation. Any one who has re- for his eyes or for those of his men will admit the former true all will probably agree that good ation is desirable, for, without it, soon become fatigued and dull. aking of this reminds me of a visit le a short time ago to a shop having artmental drafting rooms where e was a decided and visible differ- ence in the condition of the men due to the lack, in one of the departments, of that one essential—ventilation. The room referred to was on the top floor, directly under the roof, windows on one side only, and having but one door. The distance from floor to ceiling could not have been more than ten feet, and one can imagine the condition of the air and the height of the thermometer when the temperature outside registered eighty-five. I neglected to say that the windows of this room were on the southwest wall of the building and that the visit was made in the afternoon, when the room was at its worst.

When questioned, one of the men remarked that in July it was sometimes necessary to put ice on the bulb of the thermometer to keep the mercury from forcing the top of the tube off, while another said they could not use the glazed side of the tracing cloth as the heat melted the gelatine. I cannot prove that either of these statements is true, but I do say that if obliged to decide between the forge shop and that drafting room, and it was a matter of personal comfort, I think I should choose the former, as there I could get the benefit of an occasional breeze.

Of course, in arranging a drafting room, other departments have to be considered but I fear that this branch sometimes does not get what it deserves. When a number of different kinds of machines are manufactured, these are usually made in their respective departments; and I most thoroughly believe in the departmental drafting room under these conditions. Have each drawing room as near its own department as it is possible to get it, thus avoiding unnecessary steps and wasted time. To the head draftsman, who is called upon to inspect finished work and to confer with the foreman on new work passing

through the shop, this means not only a saving of time but a better command of the room under his charge.

I remember full well a drafting room that was across the street and up two flights from the machine shop and, even though a telephone had been installed, I spent many a weary hour tramping up and down those steps that might have been devoted to less active yet more efficient service. I also have in mind the drafting room of a company whose product is a staple article used in every machine shop and who design and manufacture their own machines for making their product. This room was located at one end of the plant, while the machine shop was at the other extreme end. This was not a small plant either, and after leaving the drawing room, winding your way among a nest of automatic machines, skipping down two flights or waiting for the elevator to take you down you find at the end of about ten minutes you will arrive at the machine shop. This in itself is not very much, but remember it would take only five of these trips back and forth to cut off one-eighth of an eight hour day. Don't you think it would pay to move that drawing room? Of course you do.

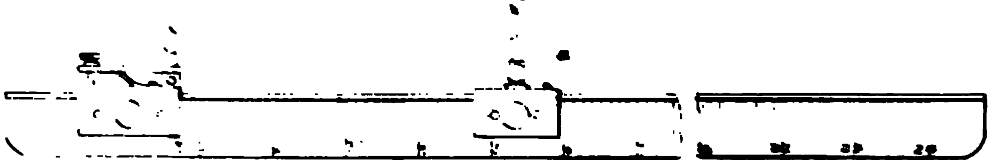
Plenty of room and good light are essentials to good work in any drawing room. I follow this statement by saying that it should be located with a north and west exposure. I hear some one asking me why I would not put it in the southwest. Strong light and direct sun light from the south and west are not [illegible] with a north and west exposure the light will be more uniform, less brilliant and consequently more satisfactory to the draftsman. For the past seven years I have had charge of a room located in the northwest corner and have found it much more satisfactory than many in which I have been employed, and especially those located in the southwest part of the building.

There are some objections wherever the room may be placed, but the only objection I can see to the location referred to above is that the blue print room may possibly have to be in some other part of the building. This is true but your blue print room has for its workman one whose wages are not great enough to be an important item in the expense column, and an electric bell will summon him to the drawing room at short notice.

If those who are working in some of the drafting rooms of our country could express themselves through the columns of this paper, I feel sure we would hear some very interesting things regarding mistakes that were made where rooms were located without much thought or were placed in a part of the building that could not advantageously be used for other purposes.

Draftsman's Kink.

Attached please find sketch of a simple device which I have found very useful, and as it may be of value to others I herewith submit it. It occurred to me when using beam compasses that if the beam, which in my case is made of cedar,



was graduated like a scale I could set the compasses to any desired place without using a rule, which often is very cumbersome.

A study of the sketch will show the device. The distance between the points in sketch shown is 4¾", using the left hand edge of the moving member (a) of the trams as indicator.

In marking the beam, place pointed tram in the desired position, say about one inch from end of beam and move the other tram so that the distance between lead and point is one inch. Mark the beam at the edge of the trams. The right hand mark will be the first inch. Then take a rule and mark off to any desired length.

I have been using this for some time, and have found it very handy, specially for design sketches; where any great accuracy is not necessary. Where this is needed the screw adjustment will be used and set to standard scale as usual.

Edwin Johnson.

Cost of Brickwork.

The cost of brickwork may be divided into two principal parts, cost of materials and cost of labor.

For common brickwork the cost of materials is a fairly constant quantity, but the labor cost varies greatly, depending on the class of work and rates of wages.

Brickwork in buildings is usually figured and paid for at so much per 1,000 wall measure. This is an arbitrary quantity and is a very different thing from kiln count or the actual number of brick. The rule usually adopted by engineers, is to figure 14 brick per square foot of 9" wall; 21 brick per square foot of 13½" wall, etc., deducting all openings. In other words 7 brick are allowed per square foot for each half brick thickness of wall. Figured this way a "thousand" brick represents 48 sq. ft. of 13½" wall or practically two cu. yds. and will be used in this sense throughout the present article. Masons frequently figure 22½ brick per square foot of 13" wall, include all openings and figure corners twice.

Some arbitrary rule is necessary because of the variation in size of brick made by different manufacturers and in the thickness of the mortar joints.

An average size brick is 8¼" to 8½" long, 4" wide and 2¼" to 2⅜" thick, although in some localities brick will be found measuring 9" x 4¼" x 2½" and in New York City many are used as small as 7½" x 3½" x 2". Brick 8½ x 4" x 2¼" with ⅜" to ½" joints will lay up about 900 brick per M.

Brick are bought by kiln count or the actual number and the price varies from $4.00 to $7.00 per M. at the yard.

Five to six dollars per M. at the yard is a fair price, to which must be added the freight or hauling.

The amount of mortar used depends on the thickness of the joints and the proportion of mortar in the wall will be about as follows:

For ⅜" joints.....................¼
For ½" joints.....................1-3
For ⅝" joints.....................2-5

or as a "thousand" brick equals approximately two cu. yds., the amount of mortar required per M. will be:

With ⅜" joints............½ cu. yd.
With ½" joints............2-3 cu. yd.
With ⅝" joints............4-5 cu. yd.

To make up a cu. yd. of 1 to 3 mortar requires about .85 cu. yds. of sand and 2 bbls. of lime or portland cement. All cement mortar is seldom used except in engineering structures or underground work, while lime mortar is used only in the cheaper classes of work and should never be used in very heavy work or when exposed to dampness.

The usual practice is to use both lime and cement in the mortar, the relative proportions varying greatly according to circumstances.

One part lime and one part cement to six parts sand is a common specification but also one seldom lived up to. Figuring sand at $.50 per cu. yd., lime at $.50 per bbl. or $.20 per bu. and cement at $1.75 per bbl. the materials for a cu. yd. of mortar would cost for 1 to 3 lime mortar:

.85 cu. yds. sand at .50	$ .43
2 bbls. lime at .50	1.00
Total	$1.43

For 1 to 1 to 2 mortar:

.85 cu. yds. sand at $.50	$ .43
1.0 bbl. lime at $.50	.50
1.0 bbl. cement at $1.75	1.75
Total	$2.68

For 1 to 3 cement mortar:

.85 cu. yds. sand at $.50	$ .43
2.0 bbls. cement at $1.75	3.50
Total	$3.93

One thousand brick, $8\frac{1}{4}''$ x $4''$ x $2\frac{1}{4}''$, piled up solid without mortar, equals 1.05 cu. yds. If brick cost $6.50 per M. the cost per cu. yd. would be $3.96 or practically the same as cement mortar, but more than the mortar where part lime is used.

Cement mortar does not "work" easily, being hard for the bricklayers to spread. It is partly on this account that cement is so seldom used without adding at least a small portion of lime.

The cost of the sand may be practically nothing where it is dug out of the cellar and seldom runs as high as $1.00 per cu. yd.

The labor cost may be divided into three classes, bricklayers, laborers and unloading materials.

An average first-class bricklayer should lay about as follows, in 9 hours:

In 9″ walls	1100 to 1400
In 13″ walls	1300 to 1600
In 18-22″ walls	1500 to 2200
Heavy foundations	3000 to ——

The number of openings, pilasters and corners makes a big difference in the amount of brick laid. Working on narrow piers, projections, etc., a man might find it difficult to lay 500 brick in 9 hours. The writer knows of one job on which four bricklayers, two of whom were the contractors, were building a 3′ 0″ wall, the footing for a warehouse. They ran out of brick. Two cars were set one afternoon containing 20,000 brick and the next day the four bricklayers put them all in the wall, an average of 5,000 (kiln count) a piece. No mortar boards were used, the mortar being dumped on the wall and spread with shovels, trowels being used for the outside 4″ only. In addition to the usual materials two "eighths" of beer were used. How much this increased the rate of laying I am not prepared to say.

Bricklayers are paid all the way from 30 to 70 cents per hour, but 60 cents is probably the rate most commonly met with.

To tend each bricklayer, keeping him supplied with brick and mortar and building scaffolds from one to two laborers are usually required, receiving from 17½ to 30 or even 40 cents per hour where hod carriers' unions have forced the price up. The usual rate is 20 to 22½ cents per hour.

In buildings having several stories, such as stores, warehouses, etc., where the materials can be dumped on the ground floor raised to the proper story on an elevator, and distributed in wheelbarrows to the wall, the labor may fall as low as $1.00 per M. On buildings of

this class, only one scaffold need be erected for each story, the joist serving for the lower half of the wall.

On one story factory buildings with high gables where the scaffolds have to be carried all the way up and everything handled in hods the labor will run $2.00 to $4.00 per M with laborers at 20 cents.

The cost of getting materials on the ground varies greatly depending on conditions.

In cities where the brick yards are close at hand the brick are usually delivered in wagons by the manufacturers, who make a uniform charge to cover the cost of delivery to any part of the city.

Where the brick have to be shipped in on cars, then unloaded and hauled some distance, the freight and hauling may amount to several dollars per M.

Over good paved streets a team can easily haul 1,500 brick, but over poor dirt roads 500 might make a big load.

The following tables give the actual cost of laying something over a million brick in five one-story factory buildings forming part of a large manufacturing plant. Brick cost $5.00 and $5.25 at the yards, the average price being $5.08.

MATERIALS.

Brick, 918 @ $5.08 per M	$4.67
Brick freight	1.12
Sand, ½ cu. yd. @ .40	.23
Sand freight	.13
Cement, .44 bbls. @ $2.00	.88
Lime, 2 bu. @ .20	.40
Total materials	$7.43

LABOR.

	Bldg No 1	2	3	4	5	Average
Bricklayers	$5.56	$4.40	$4.57	$4.68	$3.68	$4.16
Laborers	1.16	1.67	2.14	1.86	2.00	1.87
Carpenters	.70	.71	.86	1.15	.67	.77
Unloading Mat'l	1.16	1.16	1.16	1.16	1.16	1.16
Total labor	$9.37	$8.08	$8.73	$8.94	$7.51	$7.96

This makes the average total for materials and labor $15.39.

The cost per cu. yd. would be just half this or

MATERIALS

459 brick @ $5.08	$2.34
Brick freight	.56
¼ cu. yd. sand	.11
¼ cu. yd. sand freight	.06
.22 bbls cement @ $2.00	.44
1 bu. lime @ .20	.20
Total materials	$3.71

LABOR.

Bricklayers	$2.08
Laborers	.93
Carpenters	.39
Unloading materials	.58
Total labor	$3.98
Total materials	$3.71
Total material and labor	$7.69

On all the buildings except No. 1 bricklayers were paid 60 cents per hour and foreman 65 cents. On No. 1 local bricklayers from the town near which the plant was built were used at 50 cents per hour. They proved too expensive, however, and for the balance of the work bricklayers were imported from a large city at 60 cents.

The hodcarriers and mortar men were developed from local laborers and paid 17½ cents per hour.

Buildings No. 1 and 2 were long and low, containing about equal amounts of 9" and 13" walls.

Buildings Nos. 3 and 4 were higher and contained a somewhat larger proportion of 13" walls. Part of the brick work in No. 4 started from steel lintles at some distance above the floor line, which explains the higher cost of scaffolding.

Building No. 5 was higher than any of the others and contained more brick. It was composed of 13" walls with some 18" and 22", which accounts for the

lower cost of laying, although better foremanship was responsible for part of this.

The scaffolds were erected by carpenters at 20 and 22½ cents per hour, drawn from other parts of the work when needed.

The cost of unloading the brick, sand, lime and cement was all charged under one head, $1.10 being the average for the job. Teams were paid 30 cents per hour. The materials had to be hauled an average of 1-3 of a mile over country roads.

Allowing $.85 as the proper proportion to charge to unloading the brick, their cost delivered on the ground would be

$$\$5.08 + (1.12 \text{ freight} + .85 \text{ hauling}) \frac{100}{98} = \$7.22 \text{ per } 1000.$$

If this work were figured by the rules frequently used by masons, (22½ brick per square foot of 13" wall, openings included) the cost per M. would be about $12.75 instead of $15.30.

SAM. W. EMERSON,
310 Russell Ave.,
Cleveland, Ohio.

The foundations of the new County Building, Chicago, will consist of 120 cylindrical concrete piers, resting upon bed rock at an average depth of 115 feet below the street level and varying from 4 to 12 feet in diameter.

There are about 225,000 miles of cable in all at the bottom of the sea, representing $250,000,000, each mile costing about $1,000 [illegible] The average [illegible] [illegible] About [illegible] messages [illegible] by the [illegible] the year, or [illegible] for an one cable being up to 100 words a minute under present conditions. About 90 per cent of these are sent in code or cypher.

Hot Oil for Railroad Switches.

The greatest difficulty that railroads have to contend with in winter time is the blocking of switches with snow and ice. To overcome this serious condition attempts have been made to heat the switches with electricity, but that has proved expensive and dangerous. Steam-heated switches have also met with but little success. A new system has been developed in which oil is used in place of steam—hot oil of a special quality circulated through pipes placed between the ties. The advantage of oil over steam is that it retains the heat better, and will not chill to 25 degrees below zero. Furthermore, if it should chill, it will not expand and burst the pipes as water would when freezing.

Tug Stronger than Locomotive.

The horsepower of the average tug is much less than the average locomotive, but still its pulling force is greater. The pull of a locomotive, under favorable conditions, is one-third to one-quarter of the weight on the drivers, and could not be increased with any amount of power, as an increase in power would simply cause the drivers to slip on the track. For this reason, in designing locomotives the cylinders are so proportioned that the force produced is barely sufficient to cause the drivers to slip. The pull or traction force of a locomotive is not the same as the load it can move, but is the weight it could lift with a rope passed over the drawbar, over a [illegible] pulley.

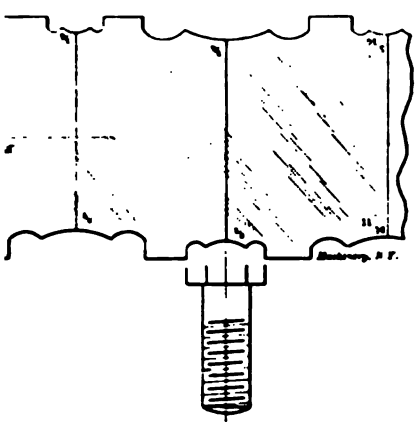
The pull of a tug depends on the size of engine and propeller and the pitch of the propeller blades.

. D. F. Murphy, the master me- : of the Great Lakes Dredge and Co., has found that a 700-hp. tug reak a 7½-in. rope with a steady while many locomotives of double orsepower could not break it with- aving a start.

en the motion of a tug is retarded rce becomes enormous. The tugs for breaking ice in rivers some- encounter sheets of ice so thick will not crack immediately. The ire of the prow then actually pul- s the ice for a short distance and irges it vertically.

late for Drawing Nuts and Bolt Heads.

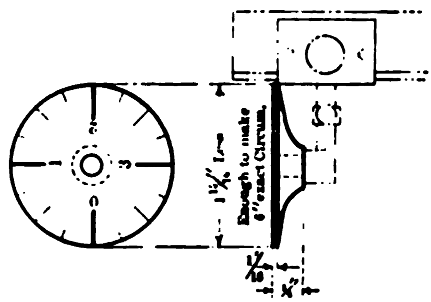
very handy template for drawing and bolt heads can be made as here i. It is made of thin transparent oid and facilitates what is perhaps ost commonly repeated work to be on a drawing. Lines are ruled on emplate which, when used, are



d over the center line on the draw- and the curved outlines can then be n. The template can be made very ly by using the bow spring dividers h after repeated use will have cut the celluloid enough to allow the s to be easily removed.—*Winamac Machinery.*"

Measuring the Length of Curved Arcs.

The accompanying sketch shows an attachment for beam compasses for measuring the length of curved lines. The circumference of the wheel is 6 inches,



ARC MEASURING WHEEL FOR ATTACHING TO BEAM COMPASSES.

and is divided into 16 parts, each part being equal to ⅜ inch, and the space between 1 and 2 being equal to ¼ of 6 inches or 1½ inches.—*A McAlpine in Am. Machinist.*

A New Steel City.

A new steel-working city is being created on the shores of Lake Michigan a few miles east of Chicago, just over the Indian state line. The entire city will be built starting with the bare ground. Mills will be erected for the manufacture of all kinds of steel, and when completed will employ 15,000 workmen. It will be a model city, in which the best ideas of the leading experts will be embodied, and all the public utilities will be laid out to best advantage, as there are no streets to tear up as yet, and no buildings in the way of doing these things right.

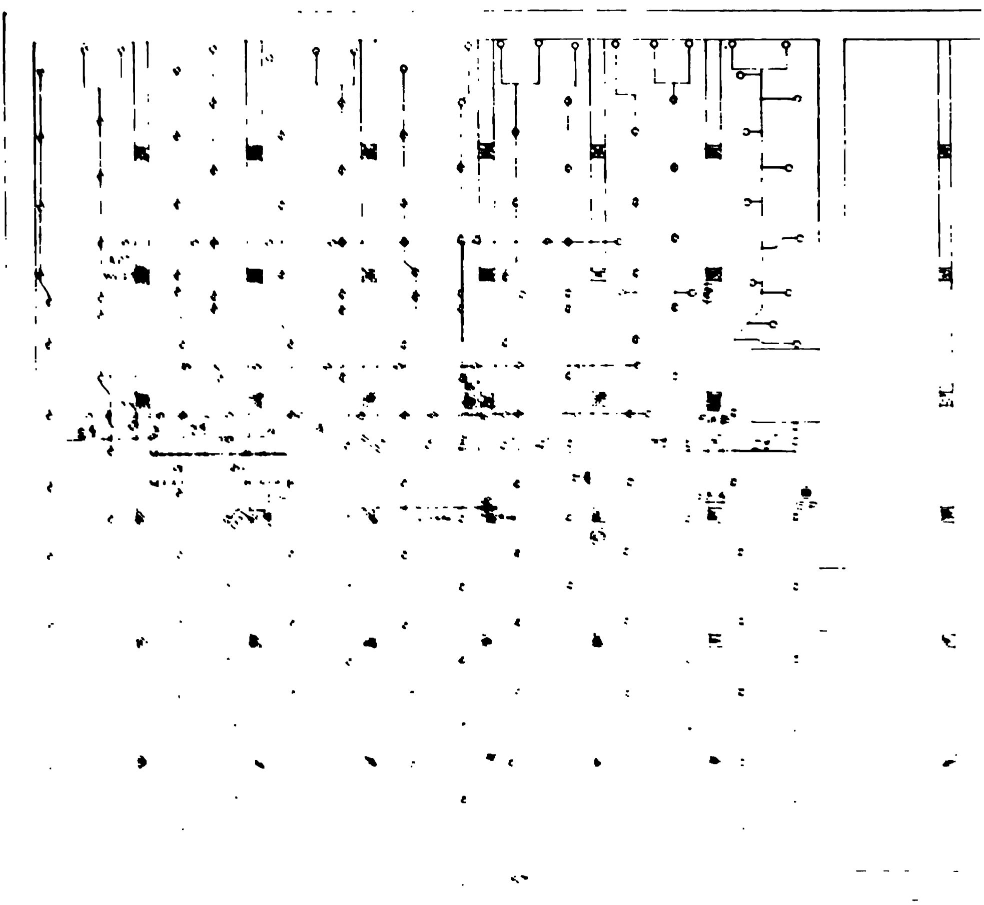
What joy and satisfaction it must be to the engineers and architects who are planning and supervising this great project.

It is seldom that men have such an opportunity as this to plan and lay out the work on a bare field and where so much capital will be involved.

The Sprinkler System as a Method of Fire Protection.

The sprinkler system of fire protection which is in extensive use in warehouses, factories, mills, stores and other large buildings in which the danger of fire is imminent because of wooden construction or inflammable goods. Compared [illegible]

lance is called a "head," is a small brass fitting which screws into a T in the pipe, heading up. The opening in the head is ½ inch and this is kept closed by a cap soldered to a sort of spring. The solder or amalgam is melted at a definite temperature say 155° F. When the temperature rises to this degree the solder melts and releases the spring, which



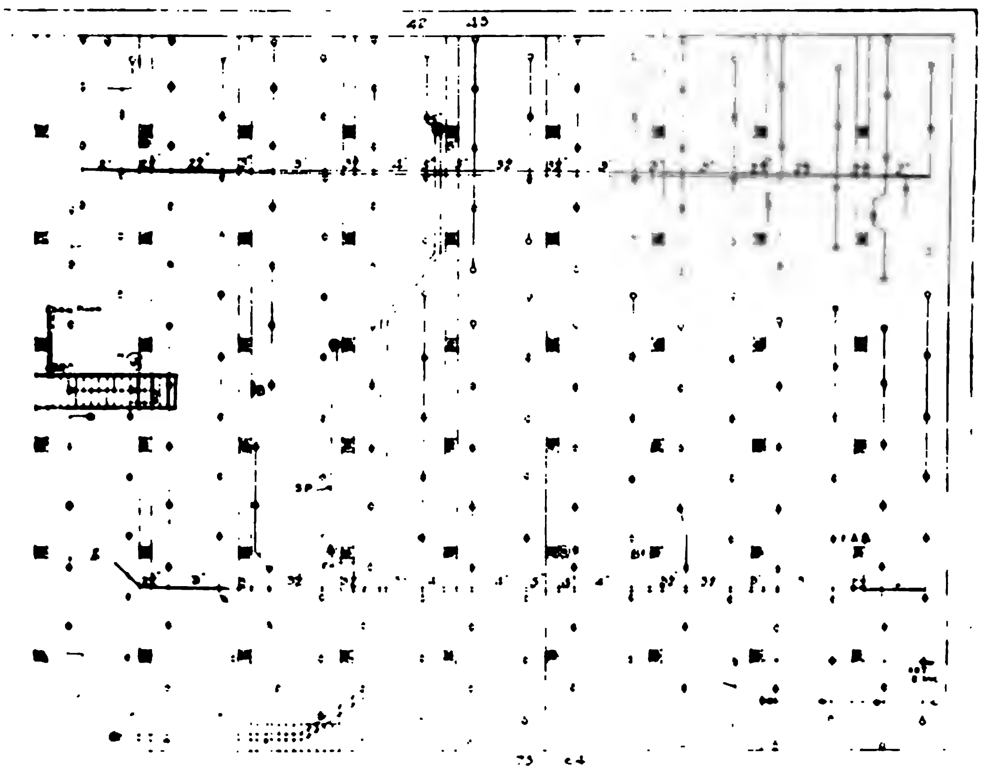
[illegible] automatic [illegible]

[illegible] the cap and allows the half inch [illegible] This stream strikes [illegible] at top of the head and [illegible] in all directions within quite [illegible] radius. The proof of the [illegible] of these heads can be demonstrated [illegible] common [illegible] One [illegible] of three or four of [illegible] have

n set off by a leak in a nearby steam e.

n installing the plant in the Wash- n Crosby mills, where we are doing own work, the first thing toward pip- a floor, after the position of the main er has been determined, is to make a n of the floor, showing the riser, the in feeder and the small pipe, with the ids, as they are expected to be placed.

made out, and then the men use the blue prints as a guide in doing the work. Of course there are many problems that arise in installing the system to the best advantage and the inspection is very strict. All of these problems must be decided before the pipe goes in and in a mill where the machines are piled up to the ceiling and sometimes reach the two floors, there are many special cases where



Chemical Buckets
Fire Hose SP - Stand Pipe
Alarm Box
Watchman's Coil

The space where no sprinklers are shown is over the place allowed for the cars to pass through the building

e distance between heads along the es is eight feet, and the distance be- een lines parallel to the beams and at ht angles to the joints being ten feet. ere a bay, or the space between two n beams is over ten feet it is required there be two lines. On the plan is put the number of heads, and from s the size of pipe required is found. om the plan the list of material is

it is difficult to cover the space properly.

The sprinkler gang, in our case, consists of a foreman and eleven men. The foreman divides his men into smaller gangs for doing particular parts of the work. First, there is the big pipe gang, which handles all the connecting pipe and the main risers and feeders. After they have installed these and connected to the pump, the fitters put in what is

called the jumpers and from there put in the smaller pipe which rises from the T in the main feeder, and terminates in another T facing at right angles to the main feeder, which is connected to the small runs. (See Figure.) After the pipe is all in a couple of men put in the heads, which are set in T's in the small feeder or pipe lines.

Having put in all the heads and completed the system, a test is made with air to locate chance leaks. The air is turned on and men are stationed on each floor, with instructions to listen for escaping air. After the air has been on for several hours and the pipes have become full, showing that there are no large leaks, the water is turned on, and it [illegible] is watched for a time, because it [illegible]

[illegible]

Heavy Haulage Chains.

The accompanying illustrations show the design of the roller chain used on incline for conveying cars to the charging floor of open hearth furnaces.

This chain is a design of the Wellman-Seaver-Morgan Co., who are pioneers and special builders of open hearth plants complete.

In the work, the furnaces are charged with the aid of a machine having a long ram, on the end of which is a head which fits one end of the steel trough known as the charging box.

These boxes are loaded with material in the yard while 3 of them stand on a car and the cars are then pushed by hand to the foot of the incline. This chain is provided with special links, located every [illegible] feet, projecting above the surface of the track high enough to engage the axle [illegible] the car.

[illegible] sprocket gears and motor [illegible] for conveying [illegible] The sprocket at [illegible] keyed to a shaft [illegible] gear, the [illegible] generally keyed direct [illegible]

[illegible] and height [illegible] vary the [illegible] amounts to [illegible]

[illegible] incline is pro- [illegible] light chan- [illegible] special links carry- [illegible] As it will be [illegible] which [illegible] the up- [illegible] turned and pro- [illegible] a hole for [illegible]

[illegible] illustration of [illegible]

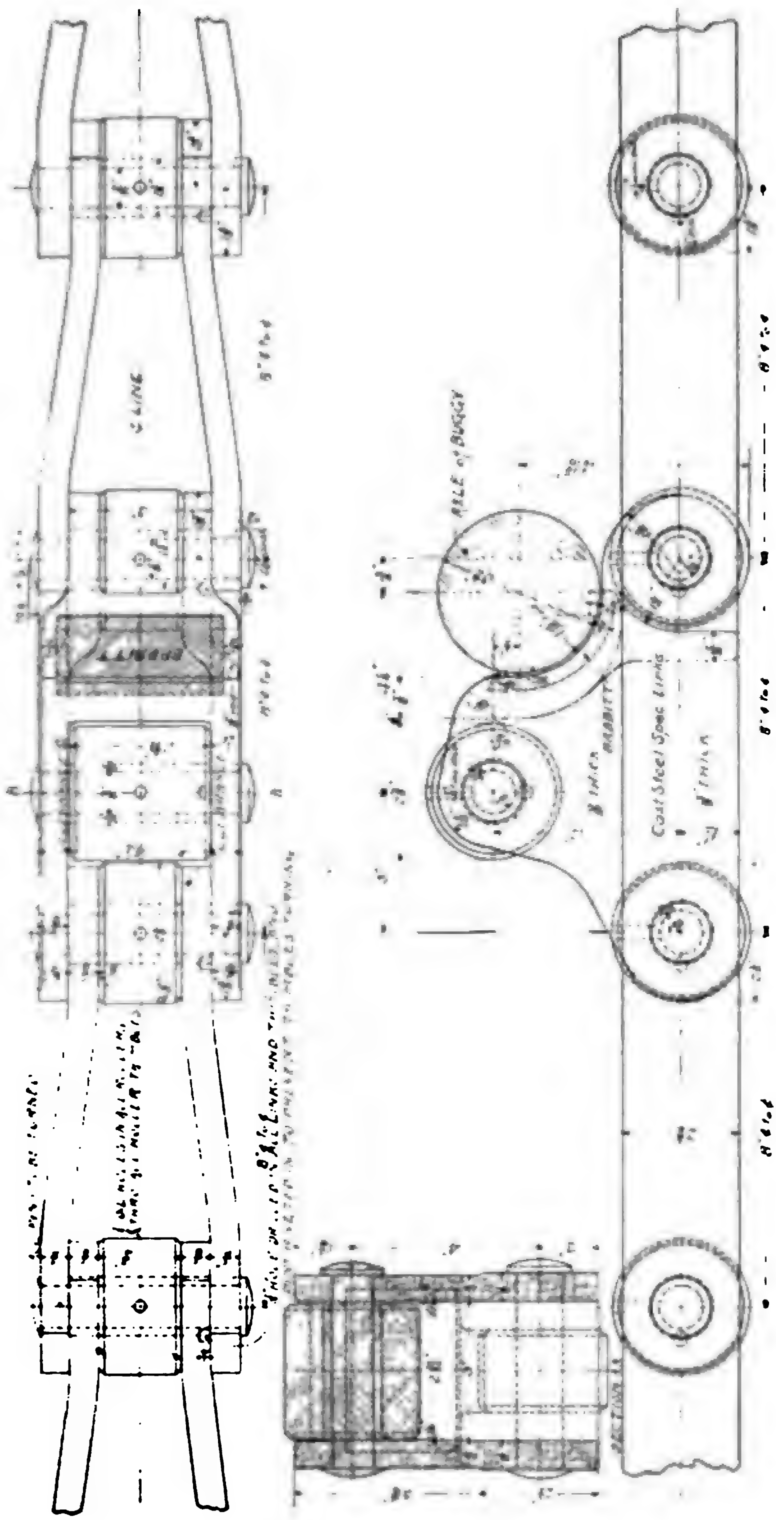


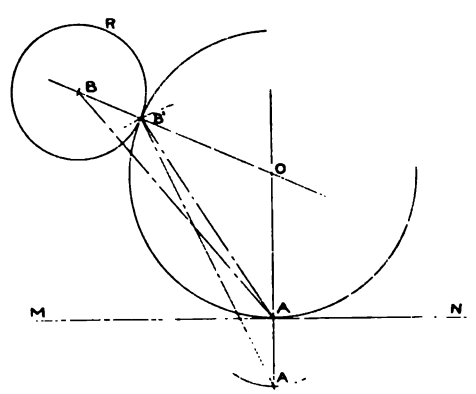
DIAGRAM OF HEAVY HAULAGE CHAINS. (See article on preceding page.)

QUESTION BOX.

(This department is in charge of Mr. A. B. BABBITT, Hartford, Conn., and questions will be answered more promptly if sent directly to him. The department is intended to give correct answers to questions of general interest. Make your question complete. Name and address must accompany each query, although neither will be published.)

6. I want to draw an arc tangent, to a given circle, and to a straight line at a given point. Is the enclosed solution correct? It seems to work out all right, but I cannot prove it.

Your solution is correct, and as it will probably be of interest to our readers, I will present it. R is the given circle, MN the given line and A the point on the line. To find O. Erect a perpendicular at A. With radius of R and A as a center draw an arc cutting the perpendicular drawn through A at A'. With radius equal to the distance from A to B and with A' as the center, draw an arc cutting R at B'. Produce B B' to its intersection with the perpendicular through A, thus giving the point O.



Proof: $\triangle BB'A = \triangle B'AA'$, sides equal, therefore $< BB'A = < B'AA'$, therefore $< OB'A = < OAB'$, supplements to equal angles, therefo.e $B'O = OA$.

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7. When asked what the three greatest powers were, I answered. "Incline, plane and pulley." Am I right?

There are many combinations of mechanism but there are only two primary elements, namely, the *lever* and the *inclined plane*. Power is transmitted by the lever through circular or angular action, that is, motion about an axis; while in the inclined plane power is transmitted by rectilinear action. The principle of the lever is the basis of the pulley, wheel and axle, etc.: that of the inclined plane is the basis of the wedge and the screw.

ENGINEERING REVIEW.

man with the muck-rake is behind es—he should use a steam-shovel. *Steam Shovel News.*

o-story hotel in New York is l. It may well stand for the exon point after one's expression of at the marvels of modern buildrprise.—*Ex.*

reported that experiments in the electricity to promote the growth crops are being carried on in the of Worcestershire, England. The ity is discharged from overhead suspended 16 feet above the , from poles 100 yards apart. The is generated by a dynamo driven orsepower oil engine at the farm s, and is transformed to high e and distributed over the wires, rent going to earth through the l consequently through the crop growing beneath the wires thus

ric Smelting of Iron Ore, By Thompson in *The Eng. and Journal* for July 7, '06. Illns of the furnace and electric ions are given.

ectrically-Operated Baggage has been built for experimental by the Pennsylvania Railroad. It of an ordinary baggage truck storage-battery equipment, opby twisting the guiding handle, the handle is dropped, the truck is stopped automatically. When the power is cut off the truck cannot be moved, the driving wheels being automatically locked by a magnet brake.—*Eng. Record.*

Comparative Tests of Alcohol and Gasoline recently made in internal combustion engines indicate a very high operating economy from alcohol, though it has only about 70 per cent of the thermal value of gasoline. The superior economy with alcohol, which has been put as high as 20 per cent, is due in part to the higher pre-ignition compression. This showing is of considerable importance in view of the removal next year of the internal revenue tax on denatured alcohol, which will, it is said, permit the commercial product to be sold for about the present price of gasoline. It is generally considered that alcohol may be used in standard gasoline engines with some slight modifications in the carburetor or vaporizing devices.—*Eng. Record.*

The cost of pumping water at Chicago is given as 2.28 cts. per 1,000 gallons in a report recently made to the Commissioner of Public Works by Mr. John Ericson, City Engineer. The cost is further classified as follows: For water that produces revenue, 6.14 cts. per 1,000 gallons pumped; for water that produces revenue and water furnished free, 5.43 cts.; for all water pumped, 2.28 cts. As to the distribution, it appears that 15% is metered water paid for, 22% is unme-

tered water paid for, 5% is furnished free (including that for the city's use and for fire purposes); this leaves 58% of the total amount pumped classed as "unaccounted for." The cost of pumping is said to be a very fair average, but varies slightly from year to year, depending on the price of coal, etc. The cost as given includes that of special sewerage works for the reason that they are for the protection of the purity of the water supply.

Engineering News.

With a 3⅛ in. drill, using air at 70 pounds, pressure, starting bit 2¾ in., and finishing bit 1½ in., the time required to drill 1 foot is about 3 minutes in soft sandstones and limestones, 4 minutes in medium sandstones and limestones, 5 minutes in hard granites, hard sandstones, etc., [illegible] 8 minutes in very hard granites and traps, and 8 [illegible]

[illegible]

increases one to three inches.

THE SIZE OF FIR JOISTS.

The common rule is half span in feet plus two equals depth in inches and one-third of the depth equals the thickness.

Thus a 14 foot span is $14 \div 2 + 2 = 9$ inches deep and $9 \div 3 = 3$ inches thick.

A simple formula for the strength of a fir beam, allowing a factor of safety of 7, is $W = bd^2 + L$, where W = safe load cwts. distributed, b = breadth in inches, d = depth in inches, L = span in feet.

Then a 9 x 3 inch joist over 14 ft. span equal $bd^2 \div L = 3 \times 9^2 \div 17.3$ cwts. distributed.

Assuming the joist to be 12 inches apart or 15 inches center to center, this will give a safe load of 14 × 15-32 ÷ [illegible] = say 1 cwt. per superficial foot.

Another rule is that six tenths of the span in feet equals the depth in inches. [illegible] of the span in feet equals the thickness in inches.

[illegible] as before, a [illegible] = 8.4 inches deep. [illegible] = 2 1-8 inches thick.

[illegible] deep for every [illegible] equals 1-3 depth. [illegible] span [illegible] 14 = 7 [illegible] = 2 1-3 inches [illegible] ordinary [illegible]

BOOKS AND CATALOGS.

BOOK REVIEWS.

Many complimentary remarks have been made about our July issue, and we trust that some improvement will be seen in our August issue also.

"A Chapter on Lettering," second edition, is receiving a great amount of attention. Orders are very numerous. Price 25c.

Dimensions of Pipe, Fittings and Valves, also, is having a big sale, for there is no book on the market like it. The tables and diagrams are taken from the actual objects and comprises all kinds of articles used on drawings of pipe work. Price 50c. The Browning Press Collinwood, O.

The National Book Co., 408 Park Bldg., Cleveland, O., are gradually obtaining a stock of books for engineers, designers, draftsmen and students and want the names of men in these lines of work to mail lists to of any new articles. This company will also handle supplies and as large an assortment as convenient will be carried as soon as possible. To arrange for this and give their customers as many advantages as possible, a limited number of shares of the treasury stock has been set aside to be sold. A prospectus will be mailed to any writing for same, and it is a good proposition to consider. This company is the publisher of Trigonometry Simplified (price 50c) and other educational books.

Practical Guide for Firemen, from the pen of the well known writer, Mr. W. H. Wakeman, New Haven, Conn., contains instructions and suggestions for the care and management of Steam Boilers, Pumps, Injectors, Traps and Gages. This book in its second edition, size $4\frac{1}{2}$x6, bound in boards and cloth, well illustrated and printed. The author's characteristic style, that of simplicity, prevails and the reader is given much valuable information in the well arranged chapters. For particulars of price, etc., address the author.

Wire Rope and its Application to the Transmission of Power, etc., is the title of a neat booklet issued by The Trenton Iron Co., Trenton, N. J. Bound in cloth, it is a very serviceable book on the uses and strength of wire rope, including sheaves and tackle blocks. This company also issue a paper bound booklet on The Application of Wire Rope to Haulage, Shafts and Inclined Planes, written by Mr. Wm. Hewitt, M. E. This is well illustrated and is a complete discourse on this subject.

CATALOGS AND TRADE PUBLICATIONS.

Niles-Bement-Pond Co., New York, issued a small catalog consisting principally of illustrations showing their traveling cranes operating in stone yards, lumber yards, freight yards, etc. 6x9, 20 pages.

Pittsburgh Blue Print Co., Pittsburgh. Catalog issued by this company gives interesting descriptions and illustrations of their various forms of electric blue print machines, such as used by some of the largest concerns in the United States, which number over a hundred. The catalog contains 28 pages, 6x9.

Smith Storage Battery Co., Binghamton, N. Y., Catalog No. 2 gives illustrations and specifications of their processed plate storage battery, and their different forms as used for power plant, automobile and stationary gas engine service. The catalog contains 30 pages, 6x9.

Craig, Ridgeway & Son Co., Coatesville, Pa., has issued a bulletin on steam-hydraulic elevators, which contains some very good illustrations. It has a novel feature in that it gives the names of several millionaire concerns having their elevators in use. 6x9, 16 pages.

The Cyclopean Iron Works Co., Jersey City, issued the sixth edition of their catalog on Cyclopean Buckets. This contains some splendid illustrations, together with prices, weights, etc. 6x9, 24 pages.

The American Manufacturing Co., New York, has issued a very neat catalog entitled "The Blue Book of Rope Transmission." This contains 60 pages of good descriptions, illustrations, etc. Size, 6x8.

Alfred Box & Co., Philadelphia, have issued a catalog descriptive of their cranes. This contains several illustrations and descriptions of electric, belt driven, traveling, jib, pillar and railway power station cranes. 7½x10½, 55 pages.

Four Wheel Drive Wagon Co., Milwaukee. This company has issued a very interesting catalog showing their motor truck in the service of different industries and working under various conditions. 7x10, 24 pages.

Sprague Electric Co., of New York, issued bulletins giving many illustrations of their electric hand power traveling cranes and hoists, capacities ranging from 1 to 10 tons. Size of page 8x10½. This is sent out in a paper binder.

John A. Roebling's Sons Co., Trenton, N. J., issued a catalog having the different applications of their wire rope classified in a convenient and interesting manner with many illustrations. This catalog also gives the size of wire rope manufactured by this company, and cuts of wire rope accessories. It contains 164 pages, 9½x6½, and is put up in a heavy binder.

Reading Crane & Hoist Works, Reading, Pa., issued crane catalog No. 40, superseding No. 30, which contains illustrations and specifications of their hand and electric traveling cranes, ranging in capacity from 1 to 25 tons. Size 6x9. Sole agent, H. R. Blethen, Park Row, New York.

Alliance Machine Co., Alliance, Ohio, has issued an extensive catalog describing their overhead traveling cranes, ranging in capacity from 2 to 40 tons. This gives some very good illustrations showing their cranes operating in foundries, steel yards, machine shops, etc. It also illustrates some of their steam hammers, ore crushers, etc. 8x11, 48 pages.

Main Belting Co., Chicago. Catalog on Leviathan Conveyors issued by this company contains some excellent illustrations showing this equipment in operation. The catalog also contains descriptions, together with price list. 8x10, 14 pages.

Williamsport Wire Rope Co., Williamsport, Pa. Catalog No. 17 issued by this company contains valuable data, illustrations and descriptions relative to wire rope, its uses, etc. In the back of this is a form of information blank. By filling out same and sending to the above company, the rope best suited for service required will be recommended.

D. Round & Son, Cleveland, Ohio, have issued a catalog on chain blocks, portable cranes, trolleys, etc. This consists of descriptions, illustrations, price list, etc. As a supplement to this catalog the above company publishes a discount sheet applying to contents of catalog.

The Eugene Dietzgen Co., of Chicago, has issued a catalog on drawing materials and surveying instruments. This contains many illustrations including metric scales, drawing outfits, pocket and surveying compasses, in fact all instruments used by the draftsman or surveyor, and will be found exceedingly valuable to those classes of industry.

The Franklin Portable Crane & Hoist Co., Franklin, Pa. This company has issued a small but very neat catalog applying to their crane and hoist. This contains some excellent cuts, together with dimensions and prices. 4x7½, 24 pages.

The Yale & Towne Mfg. Co., New York, has issued a catalog containing general information, specifications, illustrations, etc., of their chain blocks, hoists, crabs, trolleys, electric hoists and fittings for same. 6x9, 65 pages.

The Lane Mfg. Co., Montpelier; Vt. Catalog issued by this company on power traveling cranes contains many valuable illustrations, together with interesting descriptions applying to same. This type of crane is Anderson's patent, and made only by the Lane Co.

De LaVergne Machine Co., New York, has issued a most interesting catalog on ice and refrigerating machinery. This contains exceedingly good views of the interiors of both domestic and foreign houses, showing this machine in operation. It might be stated here that the book is illustrated by half-tones, and the views are arranged in an artistic and clever manner.

Cleveland Crane & Car Co., Wickliffe, Ohio, has issued the following four bulletins: "G," Hand and Electric Jib, Post and Car Crane Types; "H," Hand Power Traveling Cranes; "J," Electric Traveling Cranes, and "K," Electric Hoists. These are all very well illustrated, and the descriptions are exceedingly good.

Mesta Machine Co., Pittsburgh, Pa. A very extensive catalog has been issued by this company applying to Corliss engines, rolling mill machinery and gears. This is illustrated by very good half-tones, which have been arranged in a very artistic manner. The cover is in four colors well put together. Upon the whole it is a fine piece of work.

Pawling & Harnischfeger, Milwaukee, have issued an excellent catalog applying to their cranes. This is splendidly illustrated by many excellent half-tones. It also contains a partial list of users of their equipment, same being arranged in a very neat manner. 9x12, 140 pages.

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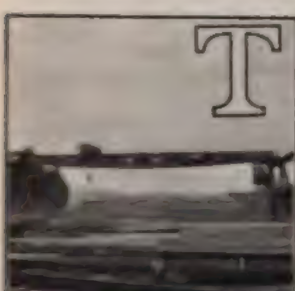
20 TON NILES ELECTRIC TRAVELING CRANE, 75 FOOT SPAN.

IN THE YARDS OF THE MILFORD STONE CO., MILFORD, MASS.

VOL. V SEPTEMBER, 1906 NO. 9

BROWNING'S INDUSTRIAL MAGAZINE

OVERHEAD TRAVELING CRANES.



THE common lifting machine in the large shops today is the overhead traveling crane, and is the result of much study and expense.

The overhead traveler would no doubt be nearly as old as the jib crane or derrick if the building and materials at hand had been sufficient to warrant its use.

To support such a machine the building must be of sufficient strength to carry the load, and not until the manufacture of iron and steel in the present shapes could this be accomplished.

Built-up members were not thought of at the time the early designers laid out the work for the first overhead travelers, yet they recognized that the distance between supports meant heavy bracing. This was accomplished by means of truss rods and standards, and the cross-section of the girder was determined by the material at hand.

The chief points to be observed in the design of overhead travelers is the making of the main girders sufficiently strong for the weight they will be required to support, and in those worked by hand power the

BROWN HOIST CRANES.

The illustration shows a group of seven 10 ton cranes handling structural material in the yards of Carnegie Steel Co., Homestead, Pa.

gearing should be of especially good construction, for it must be borne in mind that the gross weight of both traveler and load has to be moved every time the crane is put in operation.

The early cranes were hand driven and built of timber beams and wrought iron truss and tie rods.

A girder of rolled shapes and trussed rods is used today where lightness is desired with a long span. The end of the girders rest on truck wheels which run on a track supported by the building. The design and construction of these supports are matters that must receive as much attention as the girders and mechanism of the traveler.

No doubt the first design of traveler employing power was the one receiving it from a square shaft revolving on brackets near the wall of the building on the track girders. This type is still seen in operation in this country in the shops of the Washington Navy Yard. The power for all movements was transferred by shafts and gears from this main

ERECTING SHOP OF THE ROGERS LOCOMOTIVE WORKS.

Two Niles Electric Traveling Cranes are shown in the illustration. The upper is a 100 ton crane, and is equipped with two 50 ton trolleys. This crane is used for shifting locomotives from one track to another. The lower crane is a 25 ton, and is equipped with a 5 ton auxiliary hoist.

shaft. The brackets were arranged on counterweights so as to return to place as soon as the crane had passed.

No radical changes have been made in the general outline of travelers in the past few years, and only in the driving mechanism will we see the improvement. The motor with its wires and easy control has taken the place of the revolving shaft and its bobbing brackets. The type of controllers and the manner of application of power are the points on which every manufacturer bases his claims of superiority for his machine.

SPECIAL MAGNET CRANE.

Built for the bolt and nut works of the Lake Erie Iron Co. by the American Machine & Manufacturing Co. Cleveland, Ohio. This crane has a span of 55 feet, maximum capacity of 15 tons and a speed of 400 feet per minute. The speed of the main hoist is 70 feet per minute and of the trolley 200 feet per minute. The runway is 30 feet above ground.

Wheels, girders, motors, track, &c., are much alike, but rigidity, ease of movement and maximum work on minimum power are necessary factors in the design of a crane of this type.

The rope drive has received some attention, too, for it is a good way to apply the power for such work where electric current is not available. In this make of crane the rope is run along the building supports of the girders, and by means of sheaves the power is transferred to the hoisting mechanism. Friction gearing is used in the mechanism, and would no doubt aid in starting the load easier than with tooth gears.

CANTILEVER TYPE OF GANTRY CRANE

This crane has a capacity of 2 tons. The distance from center to center of rails is 50'. The working length is 150 feet. The bridge travels 200 feet per minute, the hoist 50 to 75 feet per minute, and the trolley 400 feet per minute. The above crane is located at the plant of the Alkali Rubber Co., and was built by the Case Manufacturing Co.

Four speeds for hoisting are provided on these cranes by means of clutch gears, and the train of gears are driven by a worm and gear running in a lubricating bath.

The Lane Mfg. Co., Montpelier, Vt., is alone in this class of crane, and build several sizes, the 10 ton being driven by a $\frac{7}{8}$" manila rope and a $\frac{3}{4}$" steel hoisting rope winding on a 16" drum. With this they have a bridge travel of 175 feet per minute, of the trolley 91 feet, and the hoists are 5 feet, 10 feet, 18 feet and 36 feet per minute. The largest crane (40 ton) is handled by a 1" manila rope and a $1\frac{1}{4}$" steel hoisting rope on a 20" drum. The drive sheave on this crane is 36" dia. and makes 200 revolutions per minute. They are making a specialty of stone yards and quarries.

BROWN HOIST STANDARD 10 TON 3-MOTOR ELECTRIC CRANE.

This crane operates on a circular runway, and is used for handling structural material.

CASE MANUFACTURING CO.'S TRAVELING JIB CRANE.

MACHINE SHOP OF THE WESTINGHOUSE ELECTRIC MFG. CO., WITH NILES CRANE.

With electric crane builders the speeds vary with the ideas of the designers, but the following table will show the average of the dimensions given :

Capacity in Tons.	Hoisting Speeds in Feet.	Bridge Travels Feet per Min.	Trolley Speed Ft. per Min.	Capacity of Auxil'y Hoist in Tons.	Aux. Hoist Speed.
5	25 to 60 40 to 100	300 to 450	100 to 150		
10	20 to 75	300 to 450	"	3	30 to 75
15	20 to 50	300 to 400	"	3 to 5	50 to 100
20	10 to 50	250 to 350	"	3 to 5	50 to 100
25	10 to 40	250 to 350	"	3 to 10	50 to 100
30	10 to 35	250 to 350	"	5 to 10	40 to 100
40	10 to 30	250 to 350	"	5 to 10	25 to 70
50	8 to 30	200 to 300	"	5 to 10	25 to 60
60	8 to 30	200 to 250	"	10 to 15	20 to 60
75	6 to 25	200 to 250	"	15 to 20	"
100	5 to 18	200 to 250	"	15 to 20	"
125	5 to 15	200 to 250	"	20 to 25	"
150	5 to 15	200 to 250	"	20 to 25	"

The general practice is to wind motors for 220 volts and alternating current.

THE LIFTING MAGNET.

FOR years the magnet has been an interesting freak of nature; a thing that delighted everybody and provided amusement and instruction for the young.

Is there anyone who has not known the joys of a horse-shoe magnet?

The pleasure of making pins fly through the air, of abstracting a neighbor's steel pen from his desk in school, of trying to see just how big a tack or nail should be before it refused to yield to one's special plaything.

Then it was found that the magnet of that shape did not work forever, that is, it lost some of its power and that a small bar was always placed across the ends when the magnet was laid away.

There must be an energy giving agent to make the magnet permanent and experimenters found that the electric current would restore the power.

To energize a piece of iron it was found that the current could be best carried into it by means of wire wound around it and constant experimenting has shown just what it needed in this direction.

But the lifting magnet as a practical part of the working world was not thought of till recently. About twelve years ago the first magnet was put into operation. Its mission was to carry plates from one part of the mill to another and the carrying capacity of a magnet weighing in itself 260 pounds was found to be 14,000 pounds.

The magnet was hung by chains and ring to the crane hook and the operator of the crane controlled the current to the magnet. A man on the ground usually placed the magnet and as the current was turned on, rode with the load to the pile and did the signaling for the release of the load.

At first men dreaded to work under plates or loads handled in this way for they thought the current would be unreliable.

If the current failed for an instant, of course the load would fall, but statistics show that there have been fewer accidents in shops where they are used than where the old style of chains, hooks and so on are still in operation.

MAGNET HANDLING WIRE SCRAP.

This magnet is known as No. 2 Type S Lifting Magnet, built by the Electric Controller and Supply Co., Cleveland, Ohio, and is in operation at the Newburgh mills of Am. Steel & Wire Co.

As is generally the case, one use of the magnet led thinking men to suggest it for others, and in all it has proved very successful.

The handling of the products and the waste of a big iron or steel mill has always been more or less of a problem. Scrap iron is hard to load and unload. Scrap tin is far worse. It cuts through the heaviest of gloves and shoes.

It cannot be shoveled, it has to be handled with a pitch fork and then the work goes slowly.

Baled tin, done up in bundles is also hard to handle and it took much time to fill a car with iron "pigs," and more to unload.

Magnets will handle hot castings up to a 500° centigrade.

So magnets have been made with larger surfaces, though no greater

MAGNET LIFTING SKULL-CRACKER BALL WEIGHING 11,000 POUNDS.

This is a No. 1 Type S Lifting Magnet built by the Electric Controller & Supply Co., Cleveland, O.

FIG. 2—MAGNET LIFTING KEGS OF NAILS.

The wood of the kegs does not affect the pulling power of the magnet, bolts, washers, nails, etc., being handled.

MAGNET HANDLING SCRAP.

The photograph from which the above cut was made was taken at the steel casting plant of the Wellman-Seaver-Morgan Company, Cleveland. It shows the Electric Controller & Supply Co.'s No. 2 Type S Lifting Magnet carrying miscellaneous scrap from scrap pile to the open-hearth charging boxes.

lifting force, which could be used in handling of these troublesome articles.

The magnets are made of different sizes and varying capacity.

The Electric Controller & Supply Co.'s No. 2 Type S lifting magnet 51" diameter, weighing 5,400 pounds, requiring 4' 6" head room, consumes an average of 27 amperes at 220 volts for excitation, which is 6 K.W., or 8 electrical horse power.

The Electric Controller & Supply Co.'s No. 2 Type S magnet will handle skull cracker balls up to 20,000 pounds in weight.

It handles the pieces to be broken, breaks them and then handles the broken pieces.

When operated from ordinary electric overhead traveling crane, this magnet will handle 20 to 30 tons per hour of scrap used by Open Hearth Furnaces. For 24 hours day allowing 4 hours delays this is 400 to 600 tons. If operated from a fast crane the amount may be materially increased.

LIFTING MAGNET HANDLING STEEL PLATES

This magnet is known as the Electric Controller & Supply Co.'s No. 6 Type F Lifting Magnet, and was furnished to the Imperial Ship Yards at Yokahoma, Japan, for lifting plates up to 1 1/4" thick by 8' wide by 40' long, from a horizontal to a vertical position and applying and holding them in a place while being riveted to the side of a ship.

FOUR COIL LIFTING MAGNET.

This magnet is made for general use by the Browning Engineering Co., Cleveland, O.

The amount of work accomplished by a crane and magnet depends on dimensions and whether the material is stacked or in indiscriminate pile.

An average lift of machine cast pig iron for this magnet is 1250 pounds, and for sand cast pig 1150 pounds when unloading railway cars. Heavy melting stock, such as bull heads and crop ends of billets, rails or structural shapes average 1240 pounds per lift: machinery scrap, 900 pounds; loose tin, 500 pounds; miscellaneous junk dealers' scrap, 400 to 800 pounds. Typical lifts of this magnet in handling finished products are as follows: One cast iron sewer pipe, 3 feet in diameter, weighing 2,000 pounds; eight standard T rails, 100 lbs. per yard, 8,000 lds. per lift; miscellaneous angles up to 20 feet long, 25 pieces per lift; 4"x4" angles, 37' long, 10 pieces per lift, weight of lift 4,580 lbs.; steel pipe, 5" diameter, 30' long, seven pipes per lift, weight per lift 3,000 lbs.

This magnet saves from $15 to $35 per day of 24 hours, and it is said that it is entirely possible to save as much as $50 per day.

The raising by means of a heavy magnet of kegs or light boxes full of metal articles is rather an impracticable way to handle them, because in lowering them they must be set down gently to avoid breaking.

The weight of the magnet is enough to crush the wood if it is allowed to rest on the keg or boxes. With a light magnet this means of handling is possible where the operator is careful.

The type of magnet shown in Cut 5 will carry a plate right up to the side of a ship and hold it while it is being riveted in place.

It will be noticed that the type of hanger of this magnet adapts itself to the angle of the lift. The weight of the plate would then swing it nearly vertical.

The illustrations give clearly the nature of design and some of the uses of magnets of the prominent manufacturers and it would be hard to show or tell of the endless variety of work to which apparatus of this kind can be applied.

All of the above data as to the amount of material which may be handled per lift applies to the Electric Controller & Supply Co.'s mag-

MAGNET HANDLED BY LOCOMOTIVE CRANE.

The Browning 4-Coil Magnet shown in the illustration is at work on pig iron, and is operated from a locomotive crane made by the same firm.

nets, and represent average performance under actual service conditions.

The illustration Fig. 2 was furnished by the Cleveland Armature Works, Cleveland, Ohio.

Below is a Browning Magnet handling rails. This magnet was carried by a locomotive crane.

GRADE RAISING PROJECT AT GALVESTON.

AN unparalleled engineering feat, is that of raising the grade of the city of Galveston, Texas, now well under way. The first of the measures adopted for the protection of this city was the sea wall begun in April, 1902, having a total height of 17 feet above the mean low water level. This great sea wall is now almost completed having cost a million and a half dollars.

It is not generally well known that Galveston is at present the second export city of the United States and is therefore of vast commercial importance. The entire world has marvelled at the astonishing attempt of this municipality with the aid of the county and state to elevate the whole city with its streets, parks and houses above the flood limit.

In September, 1900, the terrible flood destroyed more than five thousand lives and property valued at about forty millions of dollars. The residence district was almost entirely wiped out, Galveston being flooded to a height of 15.7 feet above mean low water.

This great project of raising the grade involved the filling in of an area of about two square miles back of the retaining sea wall. This work involved about eleven million cubic yards of filling, the average being to a depth of about 8 feet and in some places from 18 to 20 feet.

One of the engineering difficulties encountered was the problem of where to obtain this vast amount of material with a short carry. One of the suggestions was to use ordinary pumping dredges discharging over the sea wall, but this was subject to the objections of not only the wave motion at sea, but the stripping of the protecting beach.

Another suggestion was by half loading hopper dredges which steam to distributing stations on the sea front or bay front, but again this was found to be unfeasible on account of the danger of storms, the wave motion, and, if distributed from the bay, from the hindrance to traffic.

Other plans considered included the use of long suction pipes run seaward from shore stations which were to discharge over the sea wall, also by dredging and piping from a borrow pit west of the city on the Galveston Island, as well as by dredge, grab and steam shovel, using cars from a similar borrow pit.

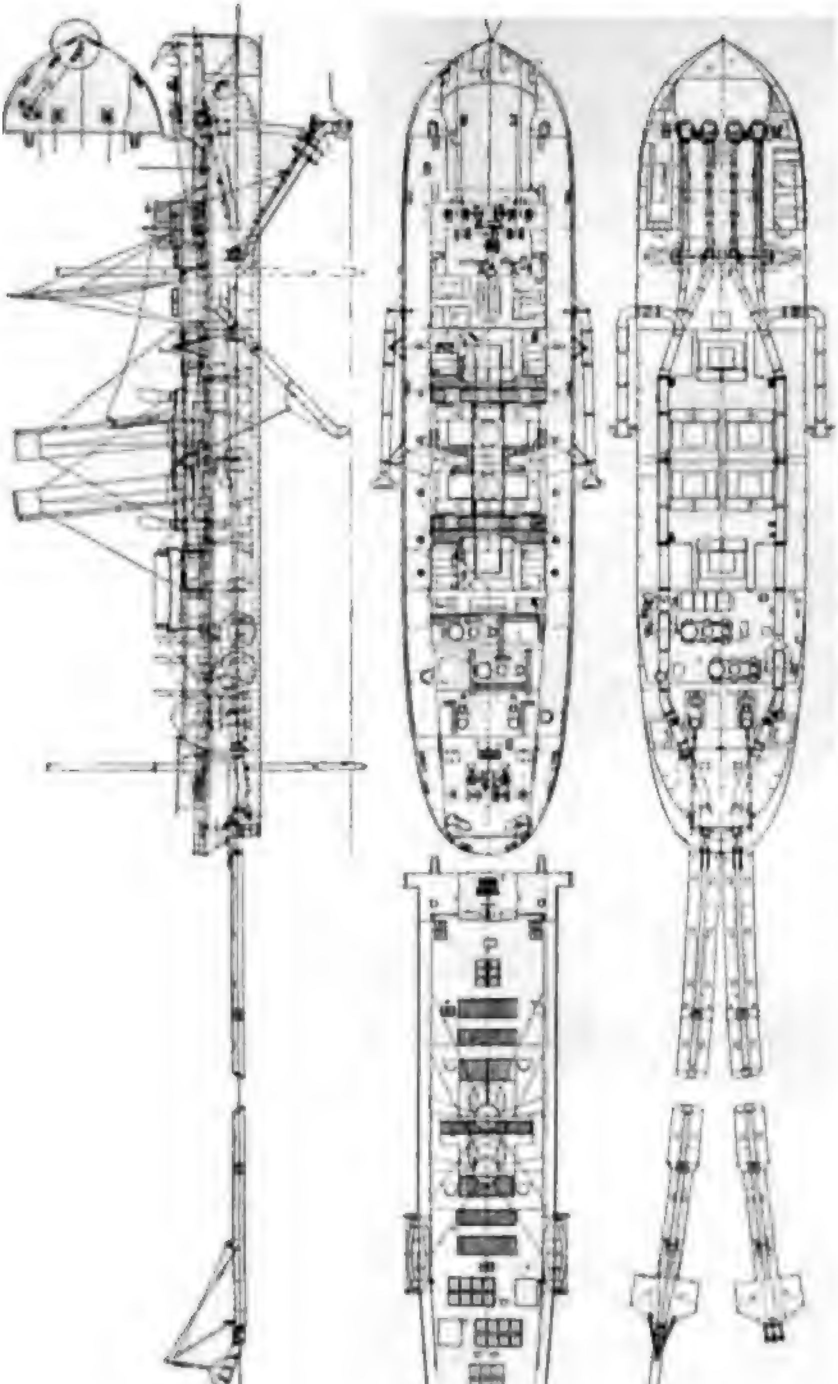
All of these methods were objected to on account of financial difficulties, the cost of relay stations, or stripping the protecting beach, while the great borrow pits would limit the growth of the city. On account of the great impediment to business, the plan of hydraulic dredging along the wharf front and piping through the streets was dropped and finally the solution was found in the plan of Lindon W. Bates, the well known engineer who has been urging the adoption of the Lake and Lock Canal at Panama in preference to the sea level canal.

The method finally adopted and now being employed to advantage includes the use of a distributing canal dug parallel and just inside of the sea wall, like a moat inside the fortifications of such cities as Antwerp, Belgium, and Dunkirk, France.

Engineer Bates claimed that this scheme had the following advantages, that material from the canal could be used to back up the sea wall and the distribution could be effected without an expensive relay system and without the disturbance of business in any way, the drainage water flowing into the canal and permiting the employment of large up to date hydraulic dredges, without disturbing the outer beach in the slightest degree.

The channels of the Bay close to the city and the navigable waters

THE HYDRAULIC DREDGE FOR WORK AT GALVESTON



OUTLINE OF SUCTION DREDGE USED AT GALVESTON.

are being deepened which alone is an improvement considered worth two million dollars, while the business center is not interfered with by pipes or its streets injured by waste water and the dredges are working continuously under shelter, there being absolutely no danger from storms.

The completion of this great project of raising the grade of Galveston to a height well above the flood level will place a definite limit to the menace which has always shadowed the fine export city of America. Directly after the great storm it was proposed by many that the city be abandoned, but after many plans had been discussed in the legislature of the State of Texas for the protection of the City of Galveston, the sea wall plan including the distributing canal, was considered a solution of the problem. A million dollars was set aside for the construction of the sea wall which was the first measure of precaution, and this concrete wall, of the strongest possible construction, is very nearly completed, with a total length of nearly three and one-half miles. Without such a wall the great tidal waves would damage the city even if raised, while even with such a wall and without the proper elevation of the grade, there would be danger of the tidal waves washing over it and being retained by it, if the water on the lower grade, which would become itself a great evil as it would prevent the return of the water.

The city's funds were supplemented by [illegible] million dollars voted by the state for raising the greater part of the city of Galveston to the upper [illegible] buildings in the con- [illegible] public [illegible] interrupted.

[illegible] is being conveyed to [illegible] filled, and the excava- [illegible] sea wall.

[illegible] the whole [illegible] of sand and water [illegible] accompanying [illegible] water being [illegible] railway and street [illegible]

[illegible] dredges will be [illegible] solid as they go. [illegible] the greatest [illegible] the navigable [illegible] vessels now con- [illegible]

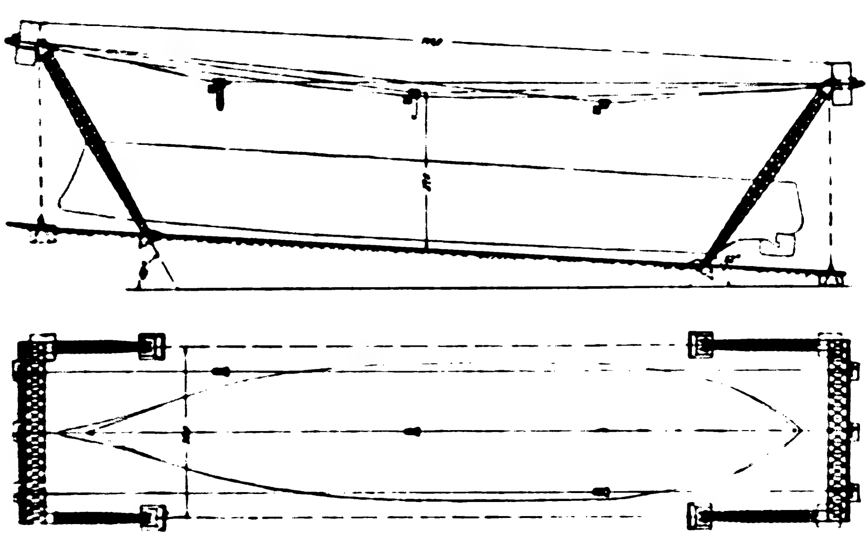
CABLEWAY FOR A SHIPBUILDING YARD.

(Translation of article in German Magazine, "Zeitschrift Des Verenes Deutscher Ingenieure."

AT the last meeting of the Institution of Naval Architects, Mr. L. Twaddell described the cableway which has been used for some-time at the yards of The Palmer Shipbuilding & Iron Co., at Yarrow on Tyne.

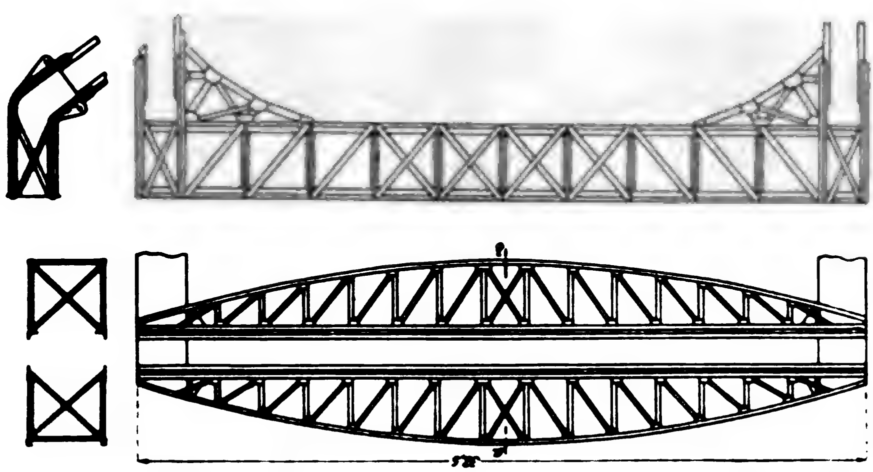
At both ends of the bedding a portal is placed, which is fastened to the foundations by means of pins on which the portal can turn. The portals are connected to each other by means of wire ropes as shown in picture No. 1, 2, 3. The dead weight of the portals keep the ropes taut, but in adddition to this, a number of ropes run from the top of the portal to the ground where they are anchored. The portal is made up to two 30 meter long posts and kept apart by two parabolic girders as shown in picture 4 and 5.

Three runways for man-trolleys are suspended from these portals. The distance between both portals is such as to allow the trolleys to cover



Figs. 2 and 3.

Pictures 6 and 7 show the trolleys running between the connecting girders of the portals posts. These trolleys carry the running rope, which is fastened in the center of the trolley. Each trolley has two vertical axles with two wheels. These axles are supported on the outside of the cords of the connecting girders. These trolleys are also fitted with four rollers with horizontal axles, which run on horizontal rails fastened to the connection girders. Each trolley is run by a 12 H. P. reversible electric motor, and the motors belonging to the corresponding trolleys on each side of the bedding are operated by the same controller from the operator's stand at one of the trolleys; for handling the load, a man-trolley is running on each one of the ropes, and the design of these man-trolleys is shown in picture number 8 and 9. The hoisting drum is placed



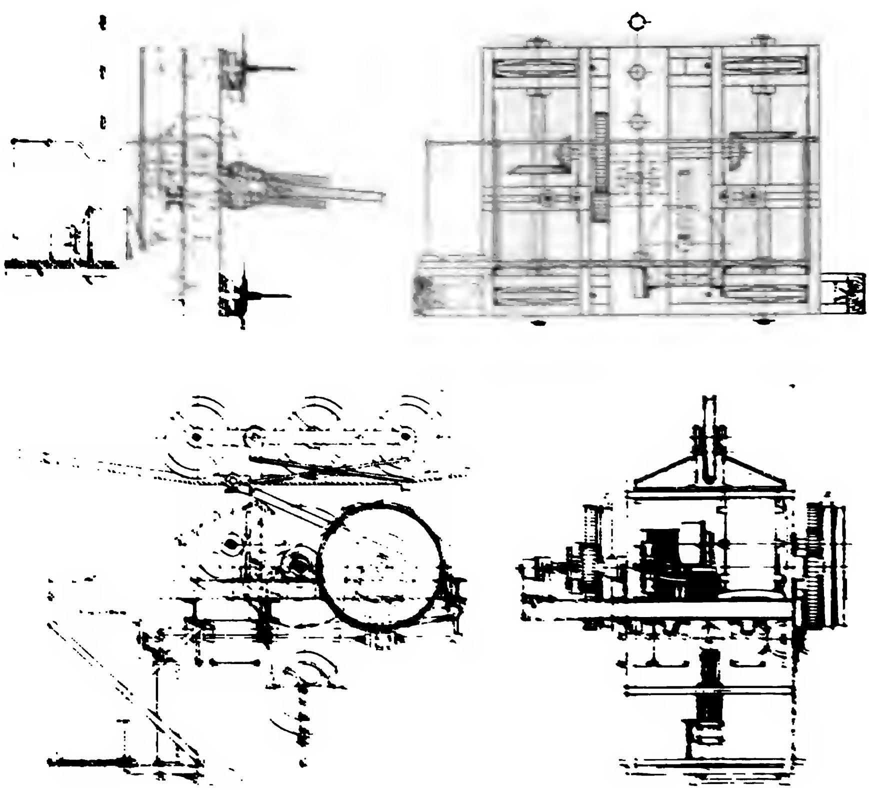
Figs 4 and 5.

in the center of the trolley, and the racking drums, one on each side, indicated by "a." These drums get their power from a 35 H. P. electric motor, which is operated from the operator's platform as shown in picture No. 8. The racking ropes are wound on the racking drums several times, and both ends are fastened at the trolleys running on the connection girders. The band brake for hoisting and racking drums are operated by hand, and each of the 3 man-trolleys have a capacity of 3 tons.

The racking speed is 180 meters per minute; hoisting speed with 3-tons load, 30 meters per minute, and with 1-ton load, 46 meters per minute. The trolleys running on the connecting girders have a speed of 7.6 meters per minute; the running ropes 197 millimeters circumference

consists of six stranded wire ropes and have a breaking load of 175 tons.

In addition to the ropes suspended between the portals, there are also three copper trolley wires strung from portal to portal to carry current to the trolleys. The whole plant, which seems to work to satisfaction, was made by the M. Henderson Co., in Aberdeen. In smaller scale and for smaller load cableways has been used for several years at shipbuilding yards in America. These cableways are of course, a whole lot cheaper than the bridge tramways and turret cranes, but as to the safety in handling the loads we don't know.



[illegible]

CAR DUMPING MACHINE.

THE BROWN HOISTING MACHINE CO. studied the car-dumping machine question carefully, and determined to produce a machine that would effect the following results:

1. Handle the coal without breakage.
2. Keep the vessel on even bilge and keel while loading.
3. Put the entire cargo aboard without moving the vessel.
4. Load the vessel rapidly and economically.
5. Handle the loaded and empty cars to and from the machine, doing away with a locomotive and train-crew.

It is claimed that no other machine has been produced that embodies all of these features, while their machine accomplishes them perfectly.

The conspicuous elements of their car-dumping machines are:

The car-tipping device or cradle, into which the car is run and then clamped, which then turns over with the car and discharges its contents.

The transfer-tubs and tub-cars, into which the coal is dumped from the car in the cradle.

The overhead traveling cranes, which take the tubs from the tub-handling cars and lower them into the hold of the vessel.

The car-pushing device and system of tracks by which the loaded and empty cars are put into and taken out of the machines.

When the cradle is in its lowest position, as shown in the picture, a loaded car of coal is pushed into same by the operator with the car-pushing device, or "ground-hog" (commonly called because it rests in a pit between the tracks when not in use so that the cars can pass over it). Once in the cradle, which will take any size gondola or hopper-car, from the largest to the smallest, the car is quickly clamped on the top and sides with hydraulic clamping-bars, and the engines set in motion, slowly turning the cradle over until the car is upside down, wheels in the air, as shown in the picture.

During the process of overturning the car, the coal has rolled, not fallen, from the car into six hopper compartments attached to the cradle, and these six hoppers have each of them entered a transfer-tub, also shown in the picture. These hopper-compartments have doors which are

"BROWN HOIST" CAR DUMPING MACHINE. SIDE VIEW SHOWING CAR PLACED IN CRADLE, AND TUB BEING LOWERED INTO VESSEL.

automatically released on touching the bottom of the transfer-tub, therefore when the cradle is returned to its original position the car of coal is left in these six transfer tubs, where it has been very carefully placed, not having been dropped or broken in any manner. It is necessary to put the coal in these oblong tubs so that it can be lowered by the cranes into the vessels. When the cradle has returned to its former position, the empty car is pushed out by the next loaded car coming in, and runs by gravity to the empty track; then the loaded car is clamped in place and the operation repeated. In the meantime, however, the tub-handling car containing the tubs just filled is pulled away by the operator from in front of the hoppers, and a car containing empty tubs takes its place.

Two overhead steam traveling cranes running over the machine at a speed of 600 feet per minute having telescopic rams (to pass the masts of vessels) which work independently of the rest of the machine, now take these tubs one at a time from the tub-handling car and lower them carefully in the ship's hold, where, after touching the ship's bottom or the top of the coal-pile, the doors are released and the coal gently rolls out as the tub is pulled away. The crane-operator then returns the empty tub to its proper position on the tub-handling car, taking the next filled tub and dumping it in the same manner. When all the tubs on this car are emptied it is returned to the hoppers for another load. The crane-operator can dump the tubs in the center of the hatch or at either side of same, and can distribute the coal to all hatches, and by this distribution of the coal it is possible to keep the vessel trimmed at all times and to keep the boat on an even keel.

Two overhead cranes are ample to handle 5,000 tons in ten hours, and the tipping device is able to handle twice as much. Therefore, with the simple addition of two extra overhead cranes, one car dumper would have a capacity of 10,000 tons in ten hours.

TYPICAL ARRANGEMENTS OF BELT CONVEYORS.

THERE is a great variety of arrangements of belt conveyors but we shall limit this article to those examples which typify the more general applications.

The ends of a belt conveyor are referred to as the head end and tail end. The head end is not, as often supposed, the end where the material is fed to the belt, but it is the discharge end. While the large pulley is sometimes shown at the head end and sometimes at the tail, it may be reversed in almost every case.

The simplest arrangement is shown by Fig. 1, which illustrates a level or inclined conveyor receiving its load at the tail end and discharging it at the head end. Fig. 2, shows a level or inclined conveyor receiving at several points, and discharging at the head end.

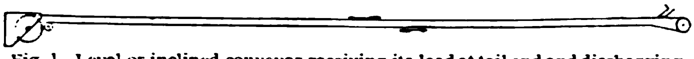


Fig 1—Level or inclined conveyor receiving its load at tail end and discharging it at head end.

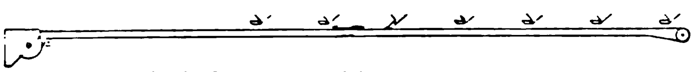


Fig. 2 Level or inclined conveyor receiving at several points and discharging at head end.

The incline at which the conveyor will work depends upon (1) The consistency of the material conveyed, and (2) The method in which the material is fed to the belt. If the material is damp or wet, and so tends to adhere to the belt, the incline can be steeper. If the material is fed continuously to the belt the incline may be steeper also.

With the larger sizes of cobbles or boulders up to 30", the maximum safe inclination of a conveyor is 18°; with smaller sizes of stones up to 4", continuously fed to the conveyor, a safe angle is 20°. With dry sands or gravel 22° is safe; and if these are damp they may be carried at as steep an angle as 25°. Material in the form of porridge can be carried at only a slight inclination depending on its consistency. Material may be carried down hill on a belt conveyor as well as up an incline.

When possible, it is good practice to place an elevating conveyor on a curved incline. Fig. 3 illustrates such a conveyor receiving from bins. The radius of the curve should not be less than 250 feet, for if it were, the belt would pull, and fail to ride in its proper position on the idlers.

Fig. 3—Elevating conveyor receiving from bins so placed as to permit of a curved incline. radius to be not less than 250 feet

When a conveyor is receiving from bins which extend too close to the head end to permit of a curved incline a tripper is placed at the proper distance from either end to admit of the proper angle on the inclined part of the conveyor. This arrangement gives us a combination level and incline conveyor as shown by Fig. 4.

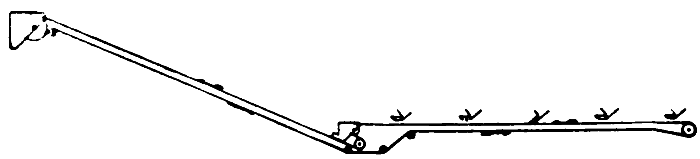


Fig. 4 Elevating conveyor receiving from bins extending too close to head end to permit of curved incline.

Fig. 5 illustrates a level conveyor with movable tripper. Movable trippers are used when it is desired that a conveyor discharge its load evenly along its entire length, as, for instance, into a continuous row of bins.

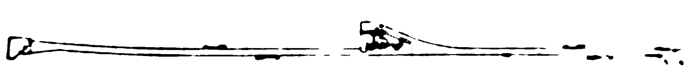


Fig. 5 Level conveyor with movable tripper

As shown by Fig. 6, a movable tripper is sometimes used on a combination incline and level conveyor. Fig. 7 shows an elevating and distributing conveyor receiving load at the tail end and discharging by a series of automatic fixed trippers.

Fig. 6—Elevating conveyor with incline, discharging into bins, with moving tripper

The operation of the fixed tripper is made automatic by having it deliver into a two-way chute, one branch of which delivers into the hopper or bin alongside the conveyor, the other branch leading back upon the belt. When the hopper is full, the material backs up in the side chute and flows into the straight chute, from which it is returned to the belt. It is then carried to the next tripper, when it is discharged, until the hopper at that point has been filled also, when it is again carried to the next, and so on.

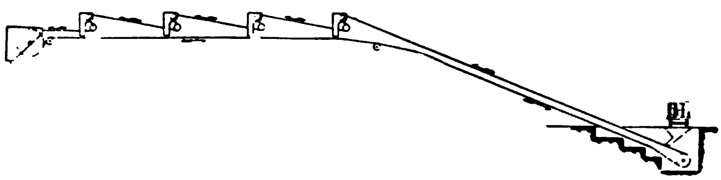


Fig. 7—Elevating and distributing conveyor receiving load at tail end and discharging by means of a series of automatic fixed trippers.

Level conveyors may be so arranged as to go by an obstruction, as, for example, a small lake or pond. In gravel pits the material is frequently carried long distances to the railroad cars, and a combination of level conveyors at right angles with trippers at the intersections is used. The material is carried up an incline, finally, to the head, and emptied into the cars. The material is put onto the belt either by hand, a grab bucket or a steam shovel.

Illustrations from Robin Conveyor Belt Co., New York

GENERAL NEWS.

...nd and Gravel Plant.

...ap as dirt" is such a common ... that we wonder at mankind ... apparatus to convert the cov- ...he earth into a merchantable ...hen some things are so plenti-

...n dirt is often applied to the ...e of sand, gravel, loam, shale, ... but it is the first two that the ...vn on the front cover has to ...principally.

...are good sand and gravel for ...urposes is often quite a prob- ...ntractors and it became evident ... was a field for this product so ...ye Dredge Co. began the work ...oto River at Columbus, O.

... always easy to get good sharp ...in this case the river bed was ... for the crude material.

...t dredge built by the Lake ...Dock Co., Sandusky, O. digs ...al from the river and deposits ... on the scow. From the scow ...d material was hoisted to the ...opper by means of a derrick ...d. grab bucket. This storage ...a capacity of 1200 cu. yds. and ... to hold 9 grades of gravel and

...in crusher is used to take care ...ger sizes of stone so that every ...ng from the river bed in the ...and and gravel is utilized.

...material passes through a re- ...reen with several sizes of open- ...ermit the different grades to ...conveyors that carry it to bins.

Teams and wagons drive up to the storage bins and receive through chutes the kind or grade of material needed.

The grab bucket will handle 300 cu. yds. in 11 working hours.

The machinery of the entire plant is operated from boilers which use two carloads (80 ton) of coal per month and this supply is handled by the Harward grab bucket. The gravel sells for 60c per yd. and the sand for 80c but it costs more to produce the gravel than the sand.

The plant is an extremely interesting and profitable one and will no doubt be the model for like concerns throughout the country, where sand is not plentiful on the surface of the ground.

The dredge, conveyor and derrick are the means employed to convert a waste to a marketable commodity.

The derrick was built by the Dobbie Foundry & Machine Co., Niagara Falls, N. Y., and is a sample of their steel built outfits.

New Design in Motor Trucks.

Nothing is more interesting to an individual, or a large corporation than some apparatus or new invention that is capable of doing a certain class of work cheaper. The new installation will often cost more than the old, but if it helps increase production, decrease cost of maintenance, or as a labor saving machine it should be welcomed with open hands.

It is only within the last five years that the automobile has come into prominence, both as a pleasure and a commercial vehicle. In case of the former the

FOUR WHEEL DRIVE WAGON USED FOR CONTRACTORS' AND BUILDERS' MATERIAL

HAULING 24,000 POUNDS SUGAR. SEVEN TONS ON FRONT WAGON AND FIVE TONS ON TRAILER

s of ones pleasure drives is greatly ised; in case of the latter greater can be carried a greater distance in ime.

the former the designs were along ine of lightness and speed with fuel ing capacity as great as possible.

e development of pleasure vehibles een carried out to a wonderful ex- and the principles of design have taken as the basis for the cabs, hos- wagons, etc., etc.

t delivery wagons the principle of ear axle drive has been followed al- entirely and the brake and steering anism is all the same. To apply r to all four wheels and also to steer, control the speed would be quite a em.

first impression, one might believe complicated, but an inspection of iechanism of the Four-Wheel Drive Wagon Co., trucks shows it to be of great simplicity.

The power is applied from engines through shafts and bevel gears, and the steering accomplished by swinging all wheels upon the vertical pivot by which they are connected to axles and all wheels move at the same time. The rear wheels follow in the path of the front wheels.

The brakes are of the internal expanding type, which do not in any way interfere with the steering. These brakes are very powerful and a necessity where heavy loads are carried on hilly streets.

The tires of these wagons are of a special wood type, which have proven to be more servicable than rubber, and the cost of maintenance is therefore reduced to a minimum.

The tires are built up of rock elm, sectors having steel wedges at the intersection with a heavy ring shrunk over a

PSON BOLT WORKS IN THE DISTANCE WITH STEAM SHOVEL IN THE FOREGROUND

shoulder. A new set can be placed at a cost of $75.00.

The engine is a special design of 45 H. P. at 750 revolutions, and has four vertical cylinders with six inch bore and six inch stroke, water cooled, oiled by splash and mechanical sight feed oiler. The ignition is by dry battery with vibrator coil and independent timer or high tension magneto with single nonvibrating coil.

For heavy haulage there would be many advantages in a four wheel drive as the propelling force would be greater, and this arrangement of steering would aid greatly in congested districts.

The illustrations shows one of the machines hauling a load of sugar weighing 24,000 lbs., seven tons on the motor truck and five on the trailer, and it is evident that such a truck is capable of pulling a greater load from the ease with which the load was drawn.

Leveling Ground for Upson Bolt & Nut Co. Building.

Several years ago the Upson Nut Co. built buildings for their works in the manufacturing district of Cleveland. The Erie R. R. run their tracks through a cut near the plant.

The growth of the business necessitated the addition of more buildings, but to do so it was either move or go up on a high hill behind the plant.

The hill or ridge of earth was purchased and contracts let for the total removal of this hindrance.

Near the opposite side of the ridge is the Cuyahoga river, which is navigable for vessels of considerable draught.

It was estimated that there was about 300,000 yds. to remove and The National Construction Co. undertook to do the leveling.

REMOVING A HILL TO MAKE ROOM FOR NEW BUILDINGS OF THE UPSON BOLT & NUT CO.

Plans were laid to sell the dirt to the "Nickel Plate" R. R. by loading cars on tracks of the Erie R. R. and to the city for filling and grading purposes.

This did not go into effect so that tracks were laid for "dinky" locomotives and side dump cars to a "dump" at the river edge where the dirt slid into scows and was then towed out into Lake Erie and deposited.

The Standard Construction Co. receive the dirt at the scows and tow it away. The scows hold about 20 cars of dirt and a scow has been loaded in 37 minutes.

Each car holds 3 to 4 dipper loads from the big steam shovel which digs the material out of the hill.

Mr. R. C. Kimble is superintendent of construction, who says that about 180,000 yds. have been removed.

The steam shovel is a Bucyrus of 70 ton capacity, and, as shown, is rapidly tearing away the hill.

A trench is dug along on the top of the hill to aid in avoiding heavy falls of dirt as the shovel cuts forward.

The Pulsometer for Contractors Use.

(Continued from article which appeared in this magazine May 18th, [illegible])

The Pulsometer requires no special foundation, and if it be desired to place it in a stationary position a stand can be supplied as shown in cut. In a suspended position it is used for sinking wells and shafts and in connection with sewers, cofferdams, excavating operations in positions where it is impracticable to provide a foundation for a pump the Pulsometer may be hung from a projecting beam, pole or tripod and arranged with suitable tackle to be lowered or raised at will. Proper flexible steam or water connections should in such cases be provided.

In quarrying or rock excavating where blasting is necessary, and frequent, the Pulsometer may, by means of the derrick, be quickly lifted out of danger and immediately be placed in position again when blasting operations are over. It has no projecting or breakable parts to be injured by rough usage.

Its capability of operation while in suspension and of being lowered or raised and hung about without at all interrupting its work, the Pulsometer stands without a rival.

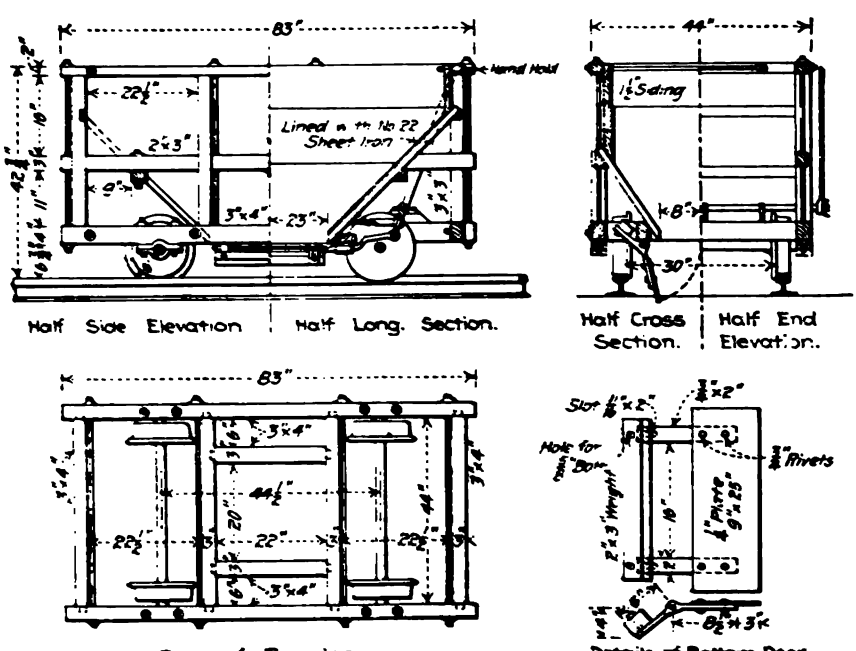
Steam is admitted at the top, or neck of the pump, enters whichever one of the working chambers the steam valve ball has left open at the time, and the expanding in it, forces the liquid downward and

through the passage leading to the discharge chamber; the discharge valve opens and the liquid passes through the discharge pipe.

The Pulsometer Steam Pump Company, 23 Battery Place, New York, who are the sole owners in the United States of C. H. Hall's Pulsometer Patents continue sending out to all parties interested their catalog describing in detail the uses and action of their pumps under various conditions, it also contains 21 tables of useful information. For example Friction of Water in Pipes, Area of Circles and their Circumference, Properties of Saturated Steam, and a table showing Safe Working Steam Pressure for Iron Boilers of Different Sizes.

A Car for Concrete.

In the construction of a low cost concrete culvert on the Nashville, Chattanooga & St. Louis Ry. a drop-bottom car (see cut) of 1 cubic yard capacity, running on 30-inch gauge tram tracks, conveyed all concrete from the mixer to the wall. The hinged bottom doors of this car were closed with a latch, which was withdrawn by means of a lever at the side of the car to dump the load. After dumping, the bottom doors closed automatically, and were latched by the lever above referred to. A trestle spanning the entire culvert, with the deck at a sufficient height to clear the top of the arch when completed, was constructed out of the old car sills, and longitudinal tracks were built on the same directly above each wall, two small turntables connecting the longitudinal tracks with a cross track that extended to the mixer. This arrangement permitted dumping the concrete into its final position in the wall without rehandling. After reaching a point 2 feet above the spring line, one of the tracks was removed and the other shifted to a position directly above the center of the arch, so as to reduce the handling of concrete to a minimum.



A DROP-BOTTOM CAR FOR CONCRETE WORK. 1 CU. YD. CAPACITY.
Nashville, Chattanooga & St Louis Ry.

Three men were required to handle the car, and they made the round trip when going to the extreme end of the culvert in about three minutes, the mixer in the meantime discharging into a small hopper, which was discharged into the car upon its return.

A Russian Gasoline-Electric Train.

Experiments have been lately carried on at St. Petersburg with a train using a new system of gasoline-electric locomotive, in which a gasoline engine is combined with an electric motor outfit. The train is made up of six steel cars mounted on two double-axle bogies. The platforms are connected with the bogies by means of ball-bearing pivots. The gauge of track is 30 inches and the wheel diameter 12 inches. The rails of the Vignole type weigh 12 pounds per yard. Each car weighs 0.7 tons, and the load is about 2 tons. At the head of the train is placed a car which is like the others on the outside, but it contains in the interior a generating set consisting of a German gasoline motor of 35 horsepower, running at 800 revolutions per minute. To the motor shaft is coupled a Bergmann dynamo. The gasoline motor is of the four-cylinder type and has 5.6-inch bore and 6.4-inch stroke. Copper water jackets are used on the cylinders. Speed regulation is secured by varying the proportion of gas in the mixture. The dynamo is designed to furnish 142 amperes and 120 volts at a speed of 780 R. P. M. The weight of the gasoline motor is 0.4 ton, and that of the dynamo 0.8 ton, while the total weight of the locomotive car, including 40 gallons of water, is 2.3 tons. On each of the bogies of the cars of the train is suspended an electric motor, which drives the axle by a 1 to 5 reduction gearing. Th[illegible]igh 110 pounds each, and they operate on a current of 60 volts, which is furnished by cables from the dynamo in the locomotive car. The two motors of each car are connected in series. Their speed is 1,000 R. P. M. A four-conductor cable connects all the cars with the locomotive. The motorman can regulate the speed of the train by a controller placed on the front car. This new system is said to operate well.—*Scientific American.*

Brick from the San Francisco Ruins.

An important feature in the rebuilding of San Francisco will be the disposition to be made of the many millions of fallen bricks from the ruins. Many of the best will be used after cleaning, a number of machines designed for that purpose being in use. The structural engineers' organization has taken up the subject of investigating the feasibility of utilizing brick bats in making concrete for building purposes. Several instances of their successful use in the vicinity of San Francisco are on record. The effects of the earthquake have demonstrated that concrete containing broken brick has stood as well as almost any other concrete.

Recent Inventions.

(Specially reported for Browning's Industrial Magazine by C. Leroy Parker, Solicitor of Patents, No. 689 F St., N. W., Washington, D. D.

CLAM SHELL BUCKET.

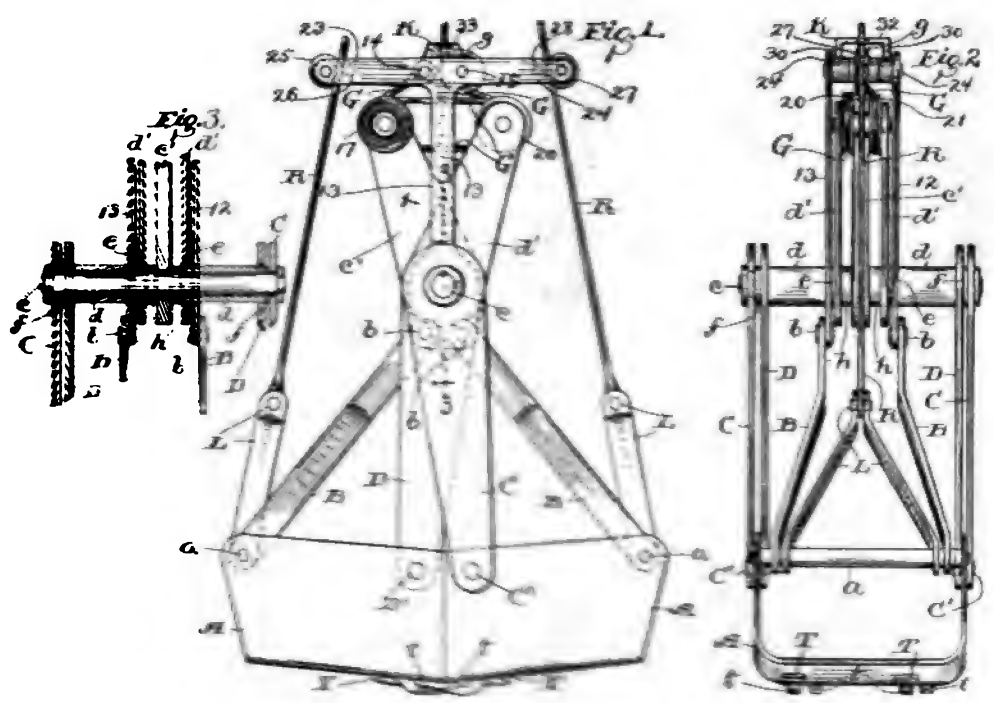
The accompanying illustration shows a clam-shell bucket invented by Gurdon H. Williams, of Cleveland, Ohio, which carries an electric motor for operating it.

Assuming the bucket to be closed, as illustrated, the front end of the scoop members will fall by gravity until the links D assume the vertical position, the rear end of the scoop members meanwhile being lifted. This action is due to the relative locations of the shafts C

C and the upper ends of the links D D, as pointed out above. The contents of the bucket can thus be discharged with the expenditure of a very small amount of force. The motor now being operated, the complete opening operation can be accomplished, as desired, through the bevel-gears H^3, H^4, pinion H^5, main gear F, pinions b, sectors C' C^2, and arms C^3.

CLAM SHELL BUCKET.

The primary object of this invention, recently patented by Robert Kaltenbach and Justin Griess, Jr., is to provide bars which are pivotally connected to the rear portions of the trays to a bail with which the bucket is centrally provided, with the pivotal connections between the said bars and the bail arranged below the axis of the bail, with the pivotal connections between the bail and the bars attached to one of the trays arranged at one side of the axes of the levers, and with the pivotal connections between the bail and the bars attached to the other tray arranged at the opposite side of the said axes, so as to advantageously place the trays of the bucket when open relative to the bed or



[illegible]

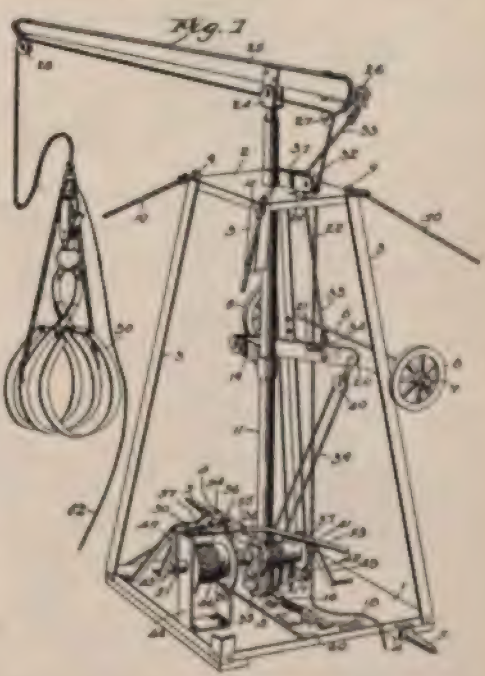
[illegible] to be excavated or operated upon.

The [illegible] are, when the bucket [illegible] and closed and suspended [illegible] material, opened by the [illegible] the bucket and contents [illegible] the cables R and releasing the [illegible] cables G. The bucket [illegible] actuating the

;' and b' upon winding up or pull- the cable G. Only one cable G loyed. The arrangement of parts that the tray-actuating mechan- id the center of gravity of the are low enough relative to the edges of the trays when the is open so that there is no liability bucket to tip when the bucket is upon an uneven pile or bed of il. Each tray is also provided at er side of the forward portion of tom thereof with teeth t, which tably spaced laterally of the said id are shown formed upon plates dly secured to the said bottom. id teeth project toward and some- eyond the forward and cutting f the said bottom and are spaced r outer ends a suitable distance he said bottom. The teeth are l to enter the pile or bed of ma- o be operated upon in advance of ting edges of the trays and have ncy to prevent upward displace- f the trays during the operation trays.

HOISTING APPARATUS.

his hoisting apparatus, recently d by John W. Johnson, of Tren- o., the load-carrying rope is ad- with relation to the hoisting level ns of the cam-lever 23 in a con- position to enable its free end to tected with the load that is to be The hoisting-rope is unwound he hoisting-drum until the free the hoisting-lever and the short the hoisting-beam have been and the long end of the hoisting- as been lowered to starting posi- After the load has been secured e 60 is unwound from the drum draft exercised thereon, thus g the hoisting-rope upon the drum l elevating the load, as will be readily understood. To swing the load into convenient discharging position, it is only necessary to trip the stop mem- ber 16 by means of the foot-lever 18, when the mast will be free to swing upon its axis, the ropes 22 and 23 being guided through the segmental slot in the cap member. While the mast is swung to discharging position the shaft 36 of the winding-drum is obviously disconnected from the shaft 45 of the drum 46; but the hoisting-drum is prevented from ro- tating reversely by the pawl 42 engaging the ratchet-wheel 41. After the load has been dumped and the mast has been re-



stored to its initial position the pawl 42 is disengaged from the ratchet-wheel 41, thus permitting the hoisting-rope to be unwound from the drum sufficiently to restore the hoisting-beam to its initial load-receiving position, the unwinding of the hoisting-rope from the hoisting drum obviously resulting in the winding of the draft-rope upon the drum 46. By manipulating the shipping-lever 53 the

Cheap Alcohol Great Help to Germany.

Arts and Crafts Have Flourished With Cheaper Product—New Possibilities In Heat, Light and power.

Berlin, July 27.—(Special).—The distillation of alcohol has for many years been an important feature of agricultural life in Germany, the annual production for the whole empire being even 20 years ago, about 80,000,000 gallons. Quite 80 per cent of the alcohol is distilled from potatoes, the remainder being obtained from grain, fruit and the by-products of the sugar and beer industries.

Up to about 10 years ago the alcohol thus obtained was consumed at home in the form of spirituous liquors, and was exported in its raw state in large quantities. Since 1887 denatured alcohol, to be used for technical purposes, has been free of duty, and the export of alcohol, except in the form of spirituous liquors, has very considerably fallen off. On the other hand the amount of alcohol used for technical purposes has INCREASED MORE THAN 500 PER CENT since that date.

About 5,000,000 gallons of alcohol are consumed annually in the manufacture of celluloid, varnish, etc., and about 4,000,000 gallons in the manufacture of vinegar. Increasingly large quantities are being used also in the manufacture of smokeless powder, but it is in the generation of POWER, LIGHT and HEAT that the German alcohol producers see their most promising future.

ALCOHOL LIGHT

A lamp to consume alcohol instead of petroleum for use in private houses has been placed on the market, and is selling by tens of thousands. At a cost of no more than the cost of petroleum it gives a steady light of 40-candle power. The flame gives off little heat, the light is white, brilliant and yet soft; there is no smell, and the lamps cannot get dirty. It has been proved that there is no danger of explosion. Different forms of lamps with higher candle power are made for lighting railway stations, public streets, farm buildings, etc.

Equally successful efforts have been made to introduce a type of motor to be driven by alcohol. The alcohol motors are both stationary and mobile, and are employed chiefly for supplying power for farm machinery, pumps, saw and other mills and electric light plants. In 1904 they consumed 800,000 gallons of alcohol. To encourage its use the association has made a special price for alcohol used for motors, about 16 cents per gallon. Transport wagons driven by alcohol are also made capable of drawing a load of six tons. Alcohol automobiles are undergoing severe tests at the hands of the German military authorities.

Alcohol is used furthermore in Germany for a multitude of smaller domestic purposes and the consumption is rapidly increasing.

It has been calculated that the crop of potatoes produced on two and one-half acres of land yields alcohol sufficient to light 12 street lamps for 12 months, or to drive a five-horsepower alcohol motor 10 hours per day, excepting Sunday, for three months.

Coaling Locomotives.

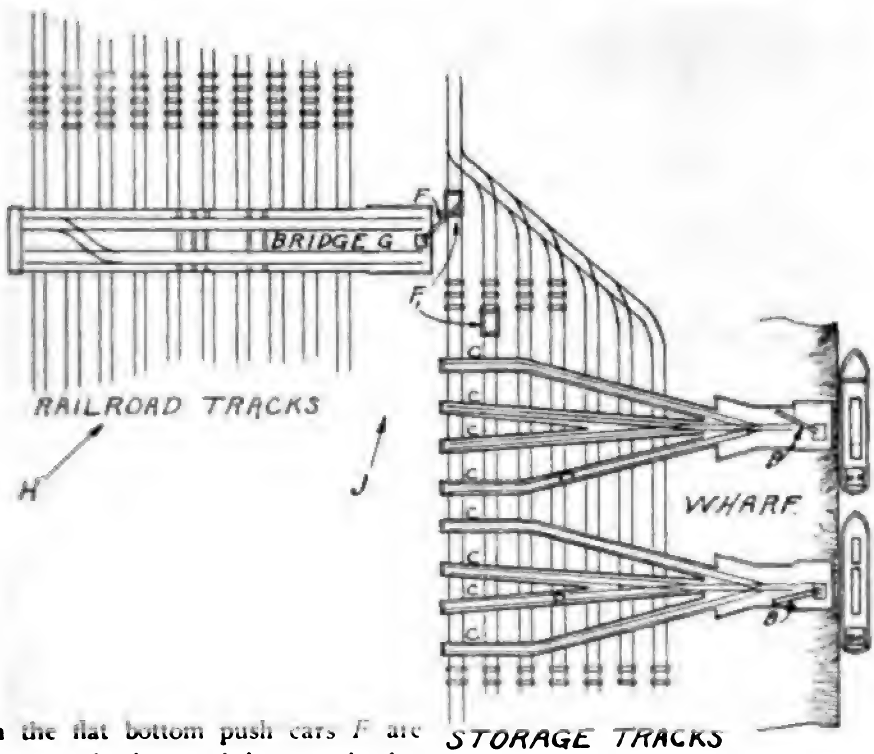
The N. Y., N. H. & H. R. R. at New Haven, Conn., has a system of coaling locomotives as shown in the accompanying illustrations.

Coal is discharged from barges at the wharf by means of clam shell buckets, which transfers it into dump cars which are gravity-run-counter weight return

and operate automatically on the elevated trestle *C. C. C.*

The trestles are built to cover considerable space for storage purposes and the cars discharge onto the piles. (See page 159, May issue this magazine, for illustration of drop bottom bucket.)

On the ground under these storage piles are tracks running from them and converging at *D* where all cars, by use of the switch back *E*, can be brought within reach of the hoist *F* which is shown in the picture.



On the flat bottom push cars *F* are drop bottom buckets and these are loaded at the storage piles, pushed out by hand on the ground tracks to the hoist *F*, where the buckets are hoisted by the pillar jib crane and steam engine, and dumped into push cars on the bridge *G*, spanning the main line and side tracks.

These cars are pushed to any point where a locomotive may be waiting for coal.

The coaling plant quickly supplies coal to the locomotives on through trains requiring to be re-fueled and also to any engines coming through on side tracks.

All operations from loading the drop bottom buckets at the storage piles to the dropping of the coal into the tender are by hand except the hoisting of the drop bottom buckets from the car truck below to the platform above.

The Skyscraper of the Future.

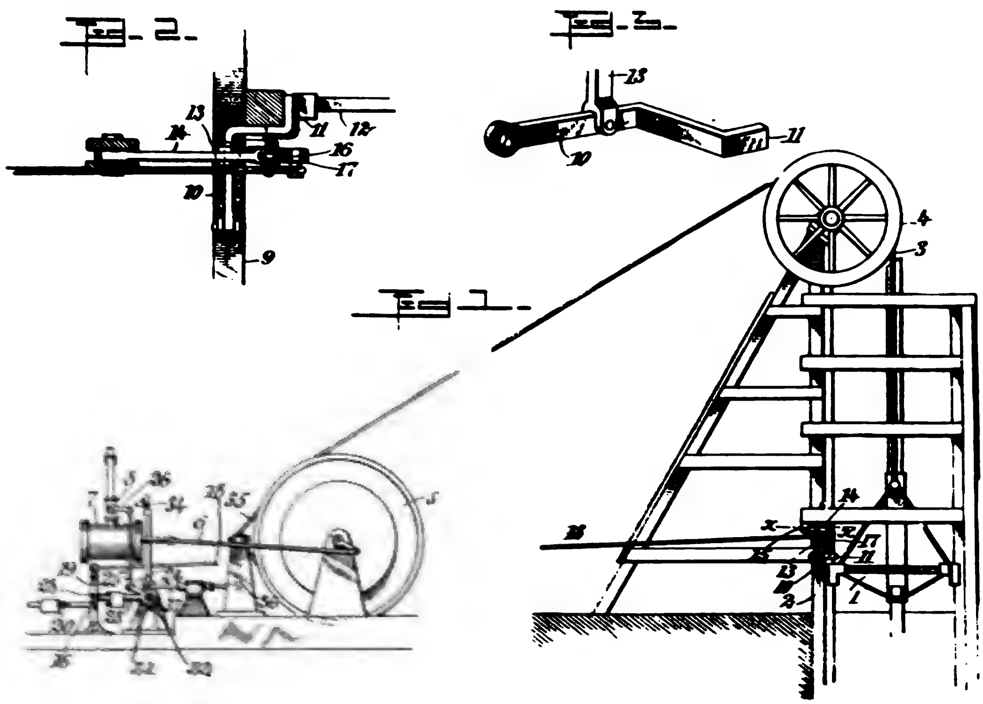
Although we have not yet perfected our method of constructing skyscrapers of such a mammoth size it is not difficult to imagine that in the future they will boast of 100 story buildings. Step by step we have advanced from the wooden hut to the thirty story skyscraper. Practically, we have reached the limit in altitude with the present type of buildings. Now we must develop something different, something larger.

We may not be ready for the one hun-

shaft 45 may be unshipped from the shaft 36 of the hoisting-drum, and the latter may then be operated manually by means of the crank 43, provided for the purpose.

AUTOMATIC STOPS FOR HOISTS.

This invention of Francis H. Kohlbraker, of Nanticoke, Pennsylvania, has particular reference to safety devices or stops for hoists or elevators employed particularly at mines, the object being



not only to provide a throttle-valve cut-off mechanism that may be operated by the cage should it rise too high in its shaft by overwinding of the hoisting-engine drum, but to provide means di-
ly under the control of the engineer
by the valve or valves may be
and the brake set to instantly stop
gine should any of the parts of
engine become disarranged, such
operation taking place without
g the automatic device thus

saving time and trouble of resetting said device.

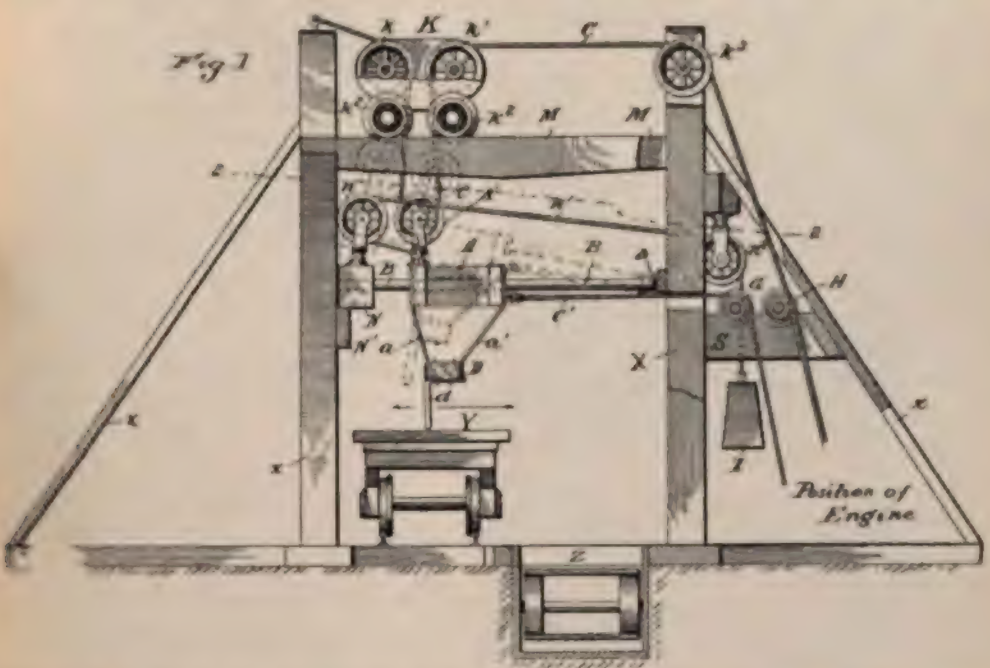
In the operation when the parts are in the position shown and the sleeve locked to the shaft 22 should there be an overwinding or the cage moved too high its cross-bar will engage the trip-lever, forcing it upward, and this upright movement of the trip-lever will move the lever 14 above the lever 16, thus permitting said lever 16 to swing and slacken the cable 18. As the cable slackens the weighted arm 20 will cause the swinging upright 10 to swing out of engagement with the end of the arm 28. Then the weighted arms extended from the shaft will cause a rotary movement thereof, immediately closing the valve or valves and also tightening the brake. As before stated, it may be necessary at times to close the valves and set the brake when the cage is in any other position than at the top. Therefore in such emergency the engineer grasps the lever 30, draw-

ing the dog 32 out of its engagement with the sleeve 27, and then, as the lever is keyed to the shaft, the lever may be rotated to close the valves and operate the brake.

CAR UNLOADING APPARATUS.

This apparatus for which a patent was recently issued to Alcide Buquet and Albert Crochet, of Minerva, Ia., is built of such height as to bring the rake d above the level of the car-floor, which is shown at Y, and the carrier-belt, which carries away the unloaded material, is shown at Z beside the car-track and at a lower level than the car-floor. Now when the loaded cars are run in on the track and stopped beneath the rake the latter is made to rake off the load onto the carrier-belt as follows: The winding up of the cable C' on the drum G causes the rake-frame and rake to move toward the windlass, dropping the material over the side of the car-floor onto the carrier. When the tension of the windlass on the cables is relaxed by reversing the engine, the weights I I restore the rake-frame to its position above the car. By locating the pulleys n n on the cross-head N of the swinging guide-rods B B (which bear the rake) the pull of the cables n' n' in carrying the rake back over the car from the gravity of weights I I is parallel with the guide-rods, and no lifting strain is put on the rods B B thereby. In this movement, however, the trolley K (which supports and regulates the height of the rake-frame and horizontal rods) follows the rake-frame back and forth, being immediately above it at all times. If the rake is to operate on the top of the load, it is raised to that level by simply winding up the cable C on the windlass, and if it is to be lowered the cable is paid out in proportion.

Fig 1



A gale blowing 80 miles an hour exerts a pressure of nearly 32 pounds to the square foot.

Leaky Valves in Pipe Lines.

Leaky valves in pipe lines are in most cases due to the abuse of the valve. There are a number of ways in which this abuse occurs. When the line is laid cement is improperly used, gets into the pipe and then lodges on the valve seat. Again, the pipe is sometimes threaded longer than is necessary, with the result that it is screwed against the partition of the valve, injuring it. The lighter valves are sometimes sprung by the wrong application of pipe wrenches, while the attempt to strain leaking stuffing boxes, instead of repacking them, is often the cause of much injury to a valve.—*Compressed Air.*

Wind Power.

The chief objection to wind power practically is its uncertainty in amount and the variable speed of the motor itself. Under stress of necessity there is little doubt that the regulation difficulty would be in great measure overcome so as to give reasonably uniform speed over a [illegible] range of [illegible] pressure. [illegible]

[illegible] per square foot) are sufficiently rare to be the subject of special record in the Weather Bureau.

An effective wind motor should be able to work at good advantage up to, say 5 pounds per square foot pressure at fairly uniform speed, and should be robust enough to stand up against winds of 50 and 60 miles an hour without going by the board. For certain uses, such as pumping, speed regulation is not necessary; but if wind power is to be included as a resource in the great power situation, even on a small scale, regulation is necessary, and it has thus far been carried out only to a very limited extent.

It is probable that winds may be relied upon for the ordinary uses of agricultural communities, although they do not form, save in the region of the trades, anything like a reliable source of power. For the larger work of power production they cannot well be regarded as important and in certain districts they are too unreliable even for casual use.—*[illegible] Magazine.*

Driving Reinforced Concrete Piles.

Concrete piles are now displacing [illegible] to some extent, especially [illegible] in salt water where the [illegible] ship worm destroys wooden piling. The concrete pile, being heavy, cannot be handled as quickly as the [illegible]. It takes about fifteen [illegible] a concrete pile from the [illegible] position for driving [illegible] pile requires from [illegible] blows, delivered at the [illegible] seven strikes per minute. [illegible] are assembled and placed [illegible] they can be handled [illegible] the same time as [illegible]—*[illegible] Eng. News.*

Painting.

The thorough painting of metal bridges is of great importance. The members of iron or steel bridges do not commonly wear out from use but they do detoriate materially through the action of rust. Iron or steel exposed to the action of the atmpospher will soon rust, and the process will continue rapidly. A paint that will preserve metal work from rusting must afford a coating that is absolutely impervious to air, moisture, or gases; it must protect the metal from the destructive influence of oxygen, which will attack it rapidly when moisture is present. A paint consists of a pigment or coloring body, ground and carried in suspension in linseed oil or other suitable carrier. The value of the pigment varies according to the fineness with which it is ground; the greater the proportion of finely ground and well mixed pigment the paint contains, the better it will generally be.

The kinds of paint most commonly used for metal bridges are red lead, white lead, asphaltum, graphite, iron oxide, and various patented mixtures. Patented paints are generally looked upon with suspicion until their value has been demonstrated. The most reliable paints for metal work are red lead and asphaltum. Of these, red lead is the better, while asphaltum is, in its first cost the cheaper. Red lead is believed to be the best paint that can be used for the priming coat on iron work. Other paints, however, are sometimes preferred for the outside or finishing coat.

Consular Reports.

The enterprise of one Chinaman is noted in the report of Consul Thornwell Haynes in this issue. Mr. Chang Chien, of Chinkiang, has established several textile, cotton-seed oil, and flour-mills, silk factory, soap factory, machine shop, etc., in all 11 establishments. Not content with this, Mr. Chien has 19 additional enterprises projected or in the course of erection, all for modern equipments with steam and electric power. Furthermore, Mr. Chien owns a fleet of steam launches, is preparing to establish a dockyard and build these boats himself, and is active in every industrial line having a promise of success. American exporters would do well to get in touch with this energetic capitalist at Chinkiang.

INDUSTRIAL NOTES.

The iron miners of Lorraine, on the French-German border, use acetylene lamps at their work.

During the year ended May, 1906, over 168,000 tons of coal reached Colon, Panama, all from the United States.

The noise of a railroad train can be heard 2,800 yards through the air and the whistle of the locomotive 3,300 yards.

The salaries committee of Stockport, England, has advanced the salary of the municipal draughtsman $2.50 a year—about 4 cents a week.

All authorities agree in stating that the ancient inhabitants of Ireland must have been very familiar with gold and well accustomed to its use.

Though willow grows in wet places, it is naturally one of the dryest woods. It contains only 26 per cent. water. Oak contains 34 per cent.

A meeting of the government board to supervise the installation of government exhibits at the Jamestown exposition, has been held. An effort will be made to equal the exhibit at Portland.

A curious well in Canada produces sand, instead of water. This sand comes up in a fine stream, like a fountain. The force which drives it to the surface from a depth of 100 feet has not yet been discovered.

Washington: Chief Engineer Stevens, of Panama canal, cabled to Washington Thursday appointment of Jos. Ripley as principal assistant engineer. He was formerly superintendent of the Sault Ste. Marie canal.

A pamphlet on the electric locomotives designed for the Simplon tunnel has been forwarded by Consul James E. Dunning, of Milan, and will be loaned by the Bureau of Manufacturers to American electrical construction firms.

A new amalgamation of steam fitting workers has been styled the Enterprise Association of Steam, Hot Water, Hydraulic Sprinkler, Pneumatic Tube, Ice Machines and General Pipe Fitters of New York and Vicinity. The agreement extends from Jan. 1, 1907, to Jan. 1, 1910, and is one of the longest on record. The fitters get an advance from $4.50 to $5 per day.

The shell and boilers of the new Cunarder being built at Wallsend, England, are said by Consul Metcalf to be constructed of the largest steel plates in the world. They are Silicon steel, weighing 10 tons each. The boilers alone will weigh over 1,000 tons. Massive ingots and slabs weighing 12 and 14 tons are continually passing through the rolling mills there for this work.

ENGINEERING DEPARTMENT

INCLUDING

DRAFTING ROOM PRACTICE.

...que German Mercury Lamps in Drafting Rooms.

BY FRANK C. PERKINS.

...he accompanying illustrations show ...construction and arrangement of a ...ging, bracket and standard mercury ...ric lamp of German construction, as ... as the rheostat employed in con...ion with the operation of the same, ...esigned by Hans Boas, of Berlin.

...hese German quicksilver lamps are ...loyed largely in German drafting ...ns and shops for lighting service, ... are said to be particularly well ...ted for this work, being restful to the eyes, supplying an abundance of light for even the closest work, and being economical in operation.

As in American photo-engraving establishments, this form of lamp has been used extensively in place of the focusing arc lamp, so in German photographic establishments as well as photo-engraving rooms the type of lamps shown in the illustrations have been utilized to advantage. The light is from 7 to 10 times as brilliant as an ordinary incandescent lamp, and three or four times greater than the Nernst lamp, while it is said to be at least three times the brilliancy of the Osmium lamp, and in some cases

LAMP SUPPORTED FROM THE CEILING

double the illuminating power of the ordinary arc light. The current consumption is said to be .5 watts per candle, the efficiency only being approximated by the other highest efficient electric light, the new flame lamp coming the nearest to the efficiency of the mercury lamp. For portrait work from 2 to 3 lamps are employed operating either singly on the 110 volt circuit, or two lamps in series on 220 volts, while these German lamps have also been constructed for operating separately on the 220 volt circuit, an adjustable rheostat being utilized as shown in the accompanying illustration which can be connected for operation with any of these three methods. The current utilized with the 50 volt lamp is 4 to 5 amperes, a beautiful violet light being emitted. The current employed on 80 volts or more is only 2.5 amperes, the lamp burning warm and emitting a whiter light than with the 50 volt current above mentioned, when the lamp burns practically cold.

With normal operation of 75 volts a current of from 2.8 to 3.5 is utilized, the lamp producing a full candle power with the normal temperature.

These German lamps designed by Hans Boas are one meter long, and are constructed of glass tubing ⅝ inches in diameter. In order to increase the candle power for photographic work where large areas are to be lighted, double lamps are provided in the same frame, operated on 220 volts. The standard upon which the mercury lamp is mounted is adjustable, so as to be turned in any direction, reflecting the light as desired, and the hanging lamps are also provided with a tilting device which can be manipulated by means of the chains shown in the illustration.

Something About Trusses.

A truss is a simple framed structure composed of straight members so connected as to act as a rigid body. It is constructed to resist the action of force by transferring it from one position to another. While the truss as a whole resists the effect of the external forces acting on it in much the same manner as a solid beam resists shear and bending moments, each individual member of the truss is subjected only to direct or compressive stress in the direction of its length. In order to bring this about, the external forces must be applied at the joints of the truss, through which they

MERCURY LAMP HUNG ON WALL OF DRAFTING ROOM.

act upon the structure as a whole.

The simplest truss is a triangle, and any truss is merely a combination of connected triangles. As the triangle cannot change its form so long as the length of each of its sides remains the same, it is the primary and essential element of the truss.

The external forces are the loads, including the weight of the structure itself, and the supporting forces, or reactions. A load is any force which tends to distort the structure or change its form.

In bridge engineering a truss is any framed structure so designed that the reactions from the superimposed static loads are vertical.

A symmetrical truss is a truss so designed that if it could be folded at the center upon itself in such manner that the two ends would come together, all corresponding members in the two halves of the truss would coincide. Nearly all trusses are symmetrical.

A simple truss is a truss whose ends simply rest on the points of support without being rigidly fixed to them. A cantilever truss is one which extends beyond its supports.

The theoretical span of a simple truss is the distance between the centres of its supports. The truss is divided into a certain number of parts or sections, usually of equal lengths, called panels. The panel lengths are the horizontal distances between the joints of the loaded chord.

When mentioned without reference to their positions in the truss, those members which resist compressive stresses are called struts, or compression members, and those which resist tensile stresses are called ties, or tension members. Each individual member, however is usually

mentioned with referencé to its position in the structure. When the diagonal members of a truss are compression members, they are called braces; the counters are called counterbraces.

A compression member can resist a certain amount of tension also; but a member designed to resist tension only is not usually capable of resisting compres-pression. When it is desired that a tension member shall resist a small amount of compression also, the form of the member must usually be changed.

THE HOWE TRUSS.

The Howe truss was devised by William Howe, in 1840. It is an excellent form and is much used in this country in localities where timber is cheap. For trusses constructed entirely of metal, however, it is not as economical as the Pratt truss.

In the modern types of the Howe truss the lower chord is usually constructed of metal. Such a truss for a through bridge is represented in the figure.

The essential difference between a

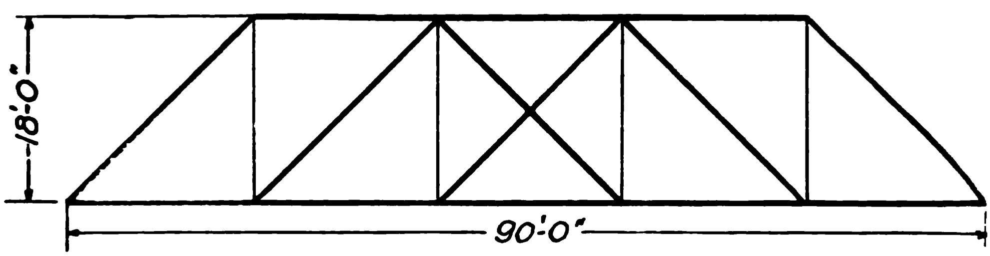


DIAGRAM OF HOWE TRUSS.

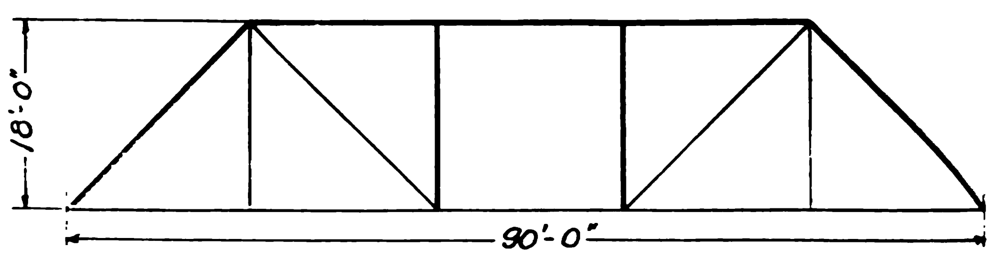


DIAGRAM OF PRATT TRUSS

When the loads on a simple truss are downwards, as is nearly always the case, the upper chord is always in compression and the lower chord always in tension. In the web system the struts and ties alternate.

The favorite style of truss now used for moderate spans is what is commonly known as the Pratt truss which was patented in 1844 by Thos. W. and Caleb Pratt. As a metal structure it possesses advantages over all other forms of trusses.

Howe truss and a Pratt truss is that in the former all vertical members are ties (tension members), and all diagonal members are struts (compression members) while in the latter the opposite is the case. The method of constructing a diagram of stresses is practically the same for both trusses.

The duties of diagonal and vertical members in the Howe truss are the reverse of what they are in the Pratt truss. The maximum stress in any vertical web member of a Howe truss, and in

the diagonal meeting it at the upper chord, occur when the joint at the foot of the vertical member and all the joints at the right are loaded, the others being unloaded.

PRATT TRUSS.

The vertical web members of the Pratt truss are struts while the diagonal members are ties.

In a Pratt truss, the maximum stress will occur in the diagonal web member in any panel when all joints at the right of the panel are fully loaded and the joints at the left of it are not loaded. This condition will also give the maximum stress (of opposite character) in the vertical member which meets the diagonal in the unloaded chord.

Pitch on Roofs.

The following table gives the minimum pitch of roofs in inches to the foot, for all different kinds of roofing material:

Asphalt and composition	½
Tin	1
Corrugated iron	3
Sheet iron	3
Copper	2
Lead	2
Thatch	6
Shingles	4
Slate	4
Tiles, Terra-cotta	4

—*National Builder.*

The Fatigue of Materials.

The ultimate strength of a material is the greatest stress to which it can be subjected by a force applied gradually and for a moderate length of time. It occurs at or just before rupture. Experiments have shown, however, that when forces below the ultimate strength are constantly or repeatedly applied, they may finally produce rupture; their effect seems to exhaust the material or tire it out, so to speak; whence the name *fatigue of metals* is applied to this phenomenon. Later experiments have shown that the true cause of the phenomenon lies in the imperfections and lack of homogeneity of the material.

The following law was discovered by A. Woehler, after a series of experiments, and is known as Woehler's law.

"Rupture may be caused not only by a force exceeding the ultimate strength, but by the repeated or prolonged action of forces below the ultimate strength. When these forces are alternately applied, the unit stress that finally causes rupture depends upon the range of stress, that is, upon the difference between the alternately applied forces. As this difference increases, the number of applications necessary to produce rupture becomes less."

The fatigue of metals is, therefore, of great importance in the design of such structures as brdges which are subjected to varying stresses, whether of the same or of opposite kinds; and it will be readily seen that the resistance of a member can not be accurately determined from considerations of ultimate strength only, but the phenomenon of fatigue must be taken into account.

Eliminating the Tracer.

SUGGESTION REGARDING THE MAKING AND ISSUE OF BLUE PRINTS.

(From "American Machinist.")

Considering the various means employed to reduce the "cost of production," doing away with unnecessary labor is probably best understood, when it results directly in the dismissal of hands hitherto deemed essential—with a consequent saving on the pay-roll. The designers and detailers may be considered necessary factors; if the tracers are to be eliminated a means must be sub-

stituted whereby the equivalent of their work may be produced at a saving. Recently the writer had the opportunity of investigating a machine designed with this end in view, which was arranged to coat a drawing made on detail paper with a hot wax solution producing a degree of transparency resembling tracing paper, the lines of the drawing remaining perfectly sharp—the result being that a good blue print might be made from the original drawing thus prepared. When a correction is necessary on the drawing, the wax coating is removed with a solvent which leaves the surface of the paper in its original state; after the correction is made it is necessary to run the sheet through the machine in order to again resore its transparency. It will be seen that this method solves the tracing problem, as an unskilled man may operate the machine, turning out work as fast as it can be run through. So far it must be acknowledged that a saving has been effected; but as no firm would think of using its original drawing each time a print is required, it becomes evident that a brown or black print must be taken from which to make the blue prints. The first cost of one of these machines might also make the adoption of this process prohibitive for small shops, and possibly for large plants, in the face of the fact that the same results may be attained with the plan adopted by the writer, which consists in making the original drawing on a tough, translucent, white paper, from which the brown prints may be made direct—with no processing. With care in the selection, a paper may be purchased that will stand a reasoable amount of erasing and will take pencil and ink as well as any detail paper.

The original drawing is put away in safety, while the brown print is filed in place of the usual tracing. As in the former case, blue prints are made from this brown print, which, however, results in a negative print, having blue lines on a white ground. If it is desired to have white lines on a blue ground as in the regular blue print (from a tracing), a second brown print must be made from the first. This second brown print is called a positive, and resembles the original drawing, insomuch that the lines are dark against a white ground. There is practically no objection to using the negative print for the blue process aside from the difficulty of making alterations on it, owing to the lines being transparent and the ground opaque, which necessitates the use of a drawing fluid that will dissolve this opaque ground where a new line is required, and also wherever it is desired to eliminate a line, the white or transparent line on the brown print must be painted out with opaque ink.

Now, in the case of the second brown print, or positive, made from the first, the ground is white and the lines brown, so it is very easily altered. If it is necessary to draw in some lines, it is done with ink as on the original drawing; and when an erasure is called for an erasing fluid (a weak solution of KOH*) is applied to the objectionable lines, which disappear immediately.

Where this method is used, involving the positive and negative brown prints, it is recommended that one class of work such as patternmaking be done from the negative; so that all the prints, or as many as practical, sent to the pattern shop, have blue lines on a white ground and those sent to the machine departments for example be made from the positive, having white lines on a blue ground. The contrast between the two sets of prints is very desirable and tak-

ing advantage of this the system may be elaborated upon to meet special requirements.

At best a tracing is merely a copy of the original and requires very accurate checking, whereas a photo print is an exact reproduction of the original drawing—materially reducing the chances of errors.

Owing to the small outlay at the start it is probably advisable to presume that an interested party would best make some trials along the above lines to satisfy himself on the points which are sure to be brought up in contention with the suggestion of a new plan. It is possible that conditions may be found where the tracer seems indispensable, but so far the writer has failed to find an instance where this system or some part of it could not be installed to advantage.

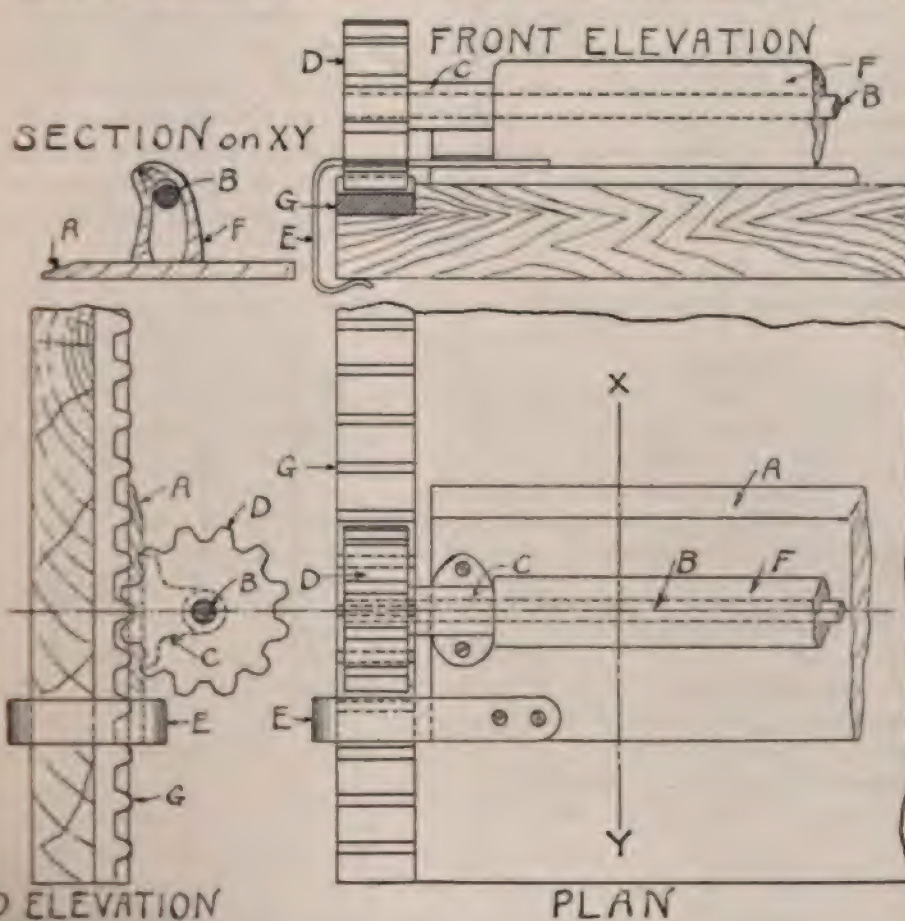
E. FARRINGTON CHANDLER.

*Potassium hydroxide, caustic potash.

Drawing Board Attachment.

The accompanying drawing illustrates a parallel rule attachment for a drawing board of about 26 inches by 20 inches.

The rule *A* has a steel spindle B of about ⅛ inch diameter along the top face, and is supported at each end by a small bearing C. Outside of these bearings, two small wheels, D, of about 10 teeth, 20 pitch, ¼ inch wide, are fixed to the spindle B. These wheels gear into two racks, G, let into the face of the draw-



ing board. Fixed to the rule, and bearing on the under side of the board are two small springs E. These springs keep the rule flat on the board. If the racks are fixed down to the board with only one screw in the center of either rack the board has a better chance to expand or shrink without affecting the parallel motion. The spindle B is covered by a curved piece of wood F which forms a very convenient means of moving the rule about. This attachment gives an excellent parallel motion, and is cheap

R. W. Dickinson,
Accrington, Eng.

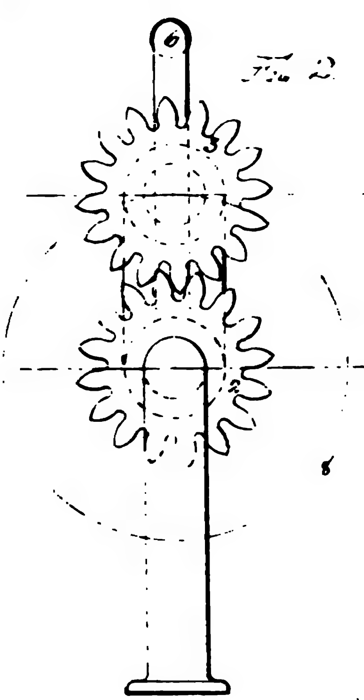
Problems in Gearing.

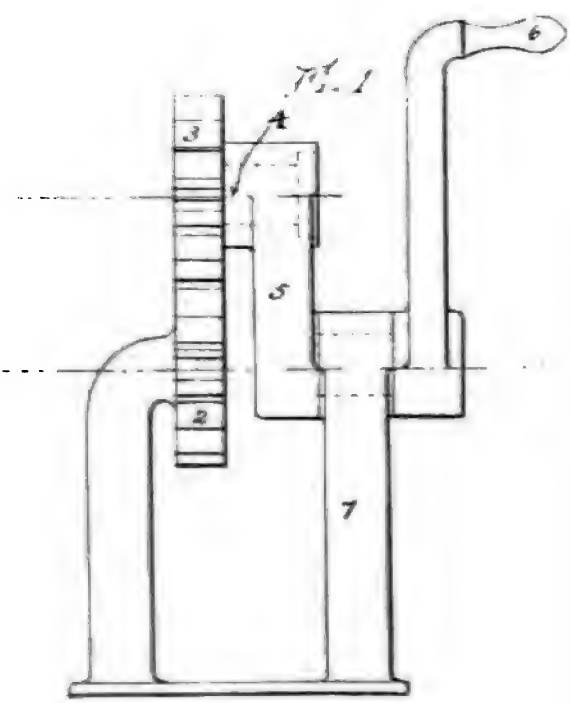
BY PROF. A. EDWARD RHODES.

Some years ago, while designing a machine, I ran up against an interesting problem in wheel gearing, one that every young draftsman should work out and give a place in his note book. Its solution not only is interesting, but a knowledge of it may save trouble, in my case it almost got to the shop before the error in speed calculation was noticed, and owing to the peculiar construction of the machine it would have been quite costly to have made the necessary changes after the machine was built, as sometimes is done; to say nothing about the cheap feeling a fellow would experience if the thing did not work right. In Figures 1 and 2.2 is a small gear rigidly secured to the support 1. 3 is a gear having the same number of teeth as the gear 1. 5 is a crank mounted to rotate in the support 7, and is for carrying the gear 3 through the path 8. The problem is by turning the handle 6 one revolution, how many revolutions will the gear 3 make about its axis 4?

Now having satisfied yourself in regards the above, try the following:

In figures 3 and 4, 1 is a gear rigidly secured to the support 10. 6 is a carrier rotatively mounted in the upright 9. 2 is a gear fitted to rotate on the pin 5 carried by the piece 6, and driven by the





gear 1. 3 is a gear fitted to rotate on the pin 4 carried by the piece 6, and driven by the gear 2. Question.—If the gears 1, 2, 3 have the same number of teeth, how many turns will the gear 3 make about its axis if the crank 8 is turned one revolution? Another one. What difference, if any, would it make if the gear 3 should be placed further from the gear 1, that is say that the centres of the three gears were in a straight line instead of forming a triangle as shown?

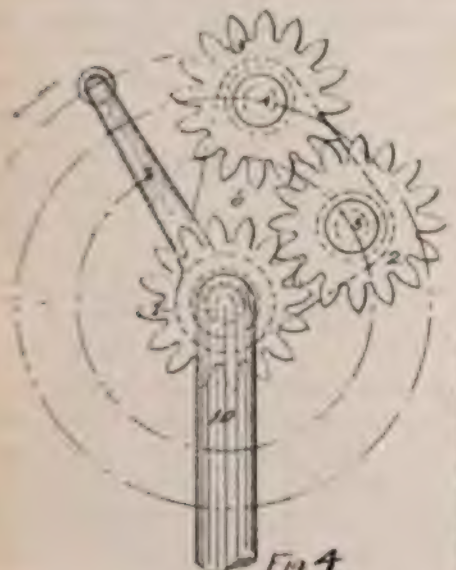


Fig 4.

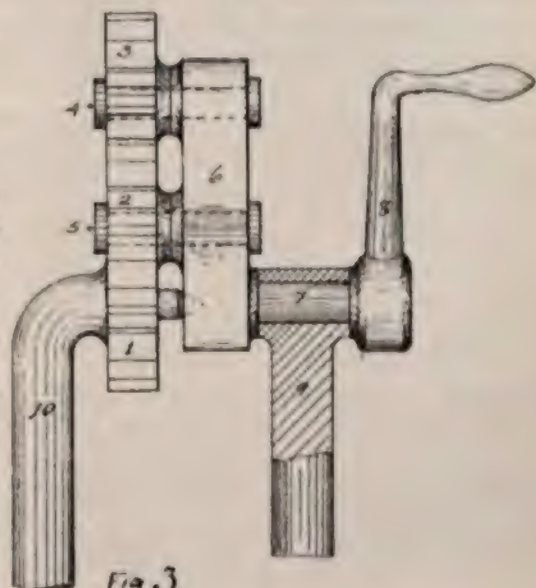


Fig 3.

Growth of Iron.

William Marriott, an English civil engineer, writing to the London Times concerning an article about the "growth of iron," says:

I have never seen this in print before, nor have I heard the term used, but during an experience of over thirty years I have felt sure that such has been the case. Rails that have fitted swing bridges with plenty of clearance have had to be shortened repeatedly year after year, and only recently I have known an instance of a swing bridge which had been open for half an hour that could not be put back until some of the ironwork had been reduced. The bridge had been built for some thirteen years, and had been opened and closed during that time many hundreds of times. There is little doubt in my mind that iron heated and cooled alternately does permanently lengthen.

Method of Enlarging or Reducing Drawings.

"From Machinery."

Very often it is desired to reduce or enlarge drawings, scroll designs, letters, lamps, etc. This can be done to scale or by proportional dividers but perhaps the simplest and quickest method is as shown in Fig. 1.

The only dimension necessary to lay off is the distance shown at *A B* which of course is the dimension desired for the reduced or enlarged copy. Fig. 1 shows the method for reducing which also applies for enlarging. It will be noticed that large and small rectangles are drawn with a diagonal line through

each, and to these lines points are projected, and from there to the space where the copy is desired. The intersection of these lines are ponits of the copy.

Fig. 2 shows line *C* reversed from that shown in Fig. 1 which causes the copy to become reversed. This is especially convenient where it is desired to obtain a right and left of any object. In making the third view of an object when detailing it is more convenient to plot it as shown in Fig. 3 than by the usual method of scaling each dimension as it can be done much quicker and with less chance of error. The diagonal line should of course be at 45 degrees in this case. In actual use, dashes cutting the diagonals are sufficient, instead of the construction lines shown in the above cuts. WINAMAC.

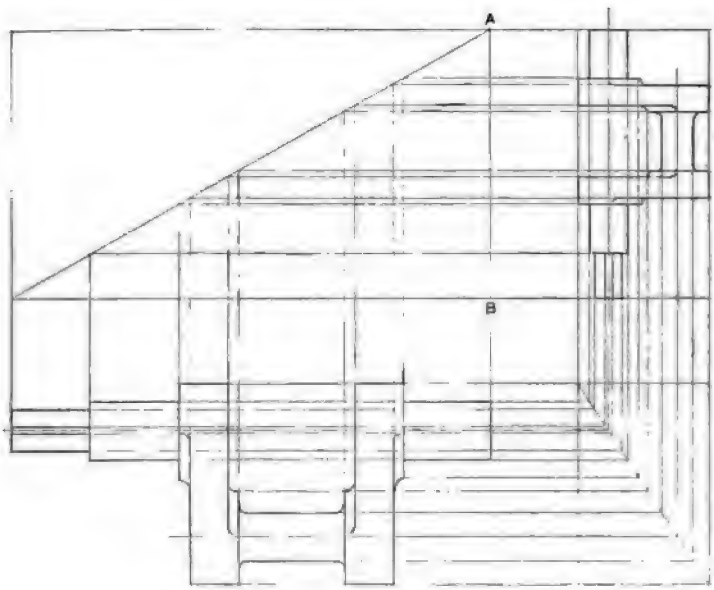


Fig. 1. A Method of Reducing the Scale of a Drawing.

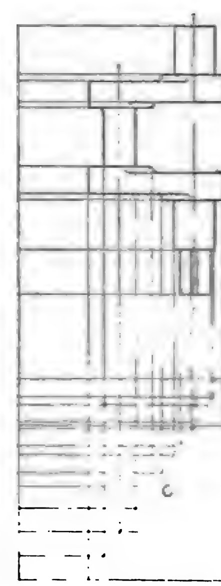
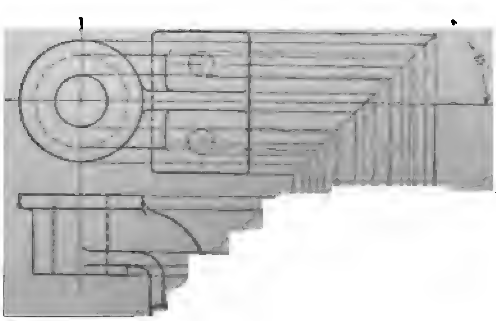


Fig. 2. Changing from Right to Left Hand.



Licensing Engineers and Surveyors.

Mr. Ernest McCullough in *Engineering World* is advocating the licensing of Engineers and Surveyors.

The idea of the writer is that the governor of each state should appoint an examining board consisting of (1) a professor of civil engineering, (2) a professor of some law school, (3) some engineer recommended by the board of directors of the state engineer's society, (4) some engineer recommended by the society of engineers having the largest membership in the state outside of the state society, (5) some engineer recom-
ed by the county surveyors of the
none of the members to be in the
y of any municipality having a
ion to exceed 10,000 unless said
e is in a department charged with

the surveying and preservation of property lines.

The board shall have a president and secretary and seal and hold its meetings at some central point. After the examinations have determined the standing of the applicant and a license is issued it is to be signed by secretary of state and a bond of $1,000.00 given.

Fees would have to be paid by the applicant to the extent of about $25.00.

Every licensed surveyor would have a seal and all work signed by him and bearing his seal would be considered prima facie evidence in any court in the state.

Section of the law should provide for the manner in which the licensed surveyor should do his work.

(Such laws would mitigate many of the evils now existing. There is no reason why doctors, lawyers and some others should be so "protected" in the collection of their bills when their services are so much of a farce as is sometimes the case. An engineer or surveyor or draftsman or any technical man must "do something" before he gets any pay.—Ed.)

Stairway to Offices.

A very convenient form of outside stairway is shown by the accompanying illustration. The design is very simple and it may be constructed quite cheaply.

The steps are supported on angles fastened to 10" standard channels on either side. Each step is made up of two 5" x 7/8" boards so that when the edge of one board becomes worn from use the rear one may be placed forward.

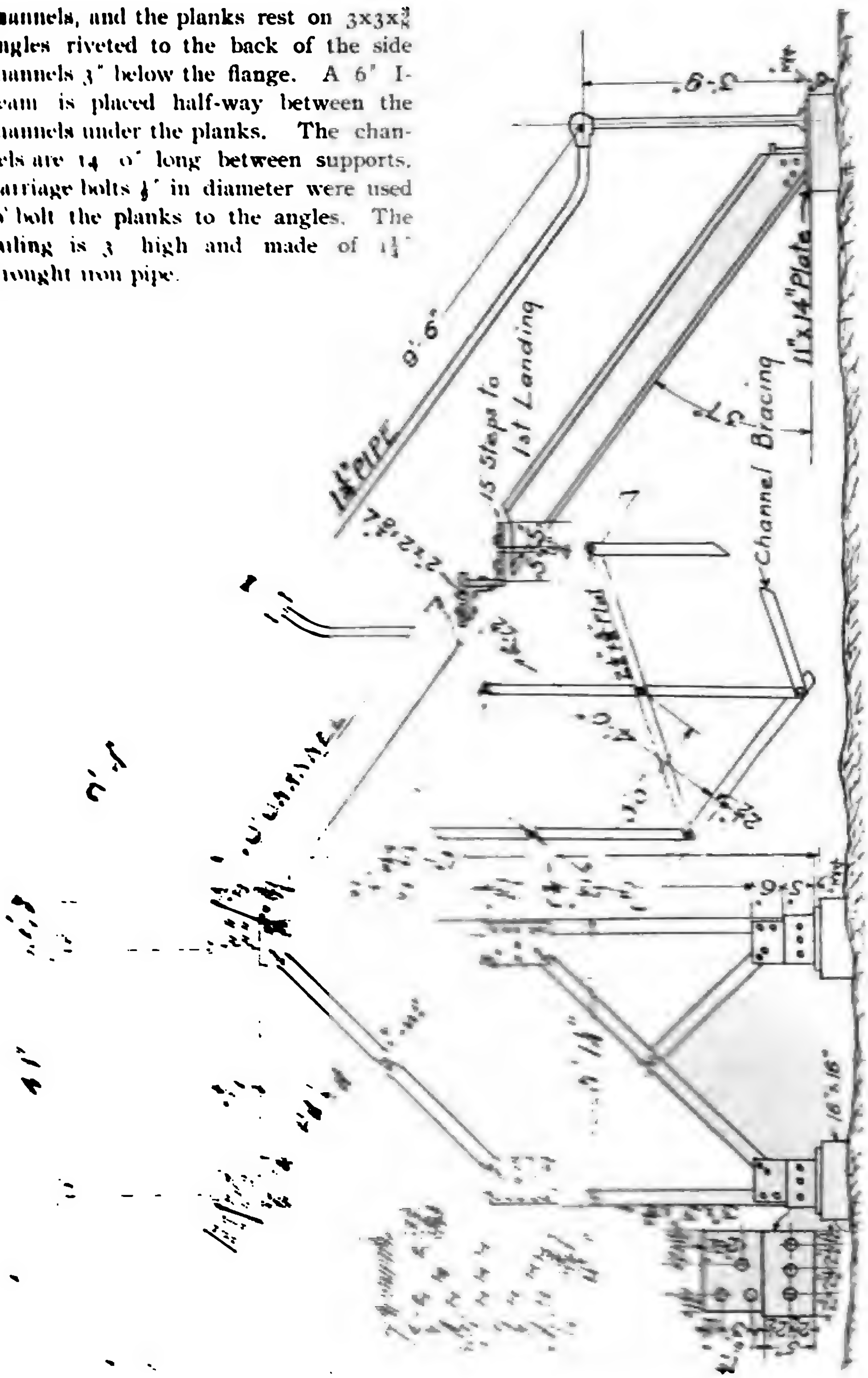
The channels are braced on the bottom by 2½" flat bars. Concrete blocks, 16" x 16" support the structure.

The crosswalk is made of two 10" channels, and the floor of the same material as the steps, but the planks are not driven up tight. By doing this, water does not stand on the upper surface.

This crosswalk is 5' 6" wide between

STRUCTURAL STAIRS TO OFFICES ON SECOND FLOOR OF BUILDING

channels, and the planks rest on 3x3x$\frac{3}{8}$ angles riveted to the back of the side channels 3" below the flange. A 6" I-beam is placed half-way between the channels under the planks. The channels are 14' 0" long between supports. Carriage bolts $\frac{1}{2}$" in diameter were used to bolt the planks to the angles. The railing is 3' high and made of 1$\frac{1}{4}$" wrought iron pipe.



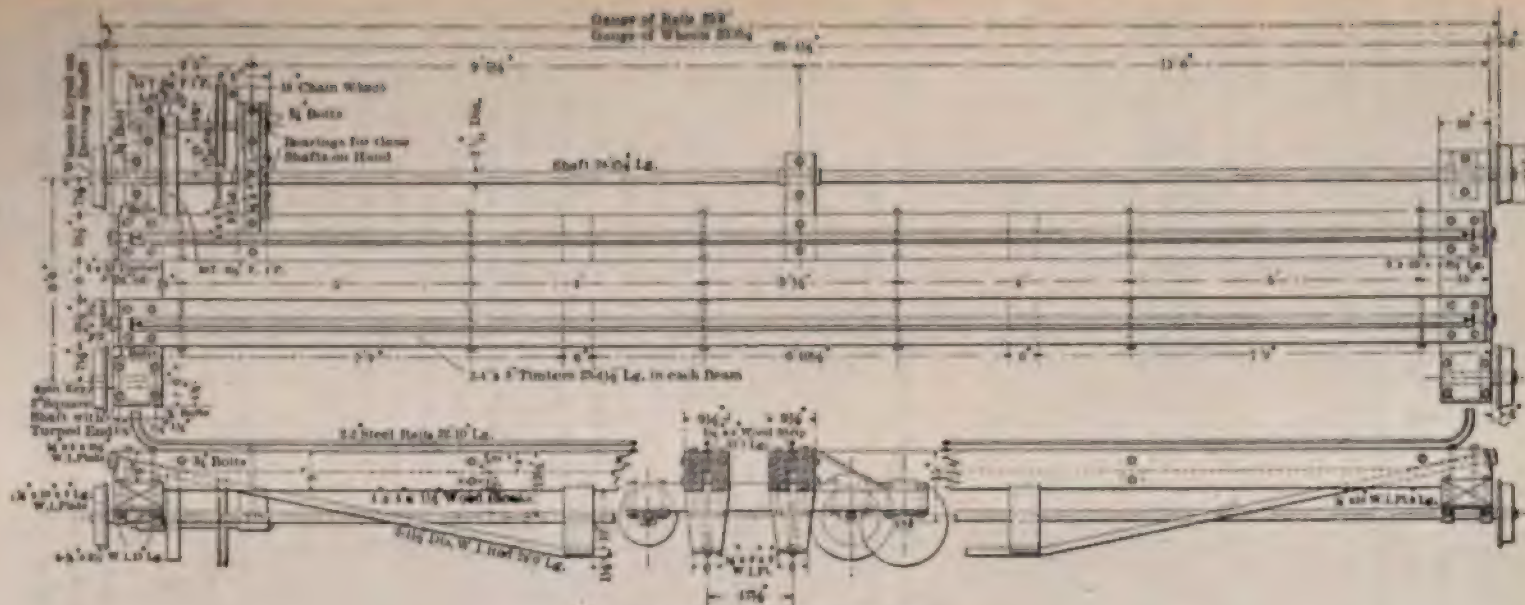


FIG. 1. A MEXICAN HOME-MADE CRANE.

A Mexican Home-Made Crane.

Thinking that perhaps the readers of the *American Machinist* would be interested in the way we do things in Old Mexico I send drawings of a home-made crane. We built a machine shop a while ago, and among the required equipment was a 3-ton crane, but because of high freight and custom charges the chief thought we could build it for less than we could buy it. At that time a somewhat similar crane to what we wanted was described in the *American Machinist*, at page 695, Vol. 28, Part 2, which gave us confidence and I was set to work on it, and the drawing shows the result. The article referred to was chiefly useful in giving us a starting point, the design as finally adopted differing considerably from the one there shown. The crane has come fully up to expectations in the matter of cost, nothing but the rough iron having to be imported, except the 3-ton chain hoist, the rest being mostly from scrap, with native timber for the bridge. The construction was necessarily light because one end of the crane is carried on a girder hung from the center of the roof truss which has a span of 50 feet, the crane covering half the width of

the shop. I include a sketch of the truss connection which may be of interest. The building is of Mexican adobe or sun-dried brick, which has a very low bearing value which limits the height of the walls and therefore the head room, so that the crane was required to operate

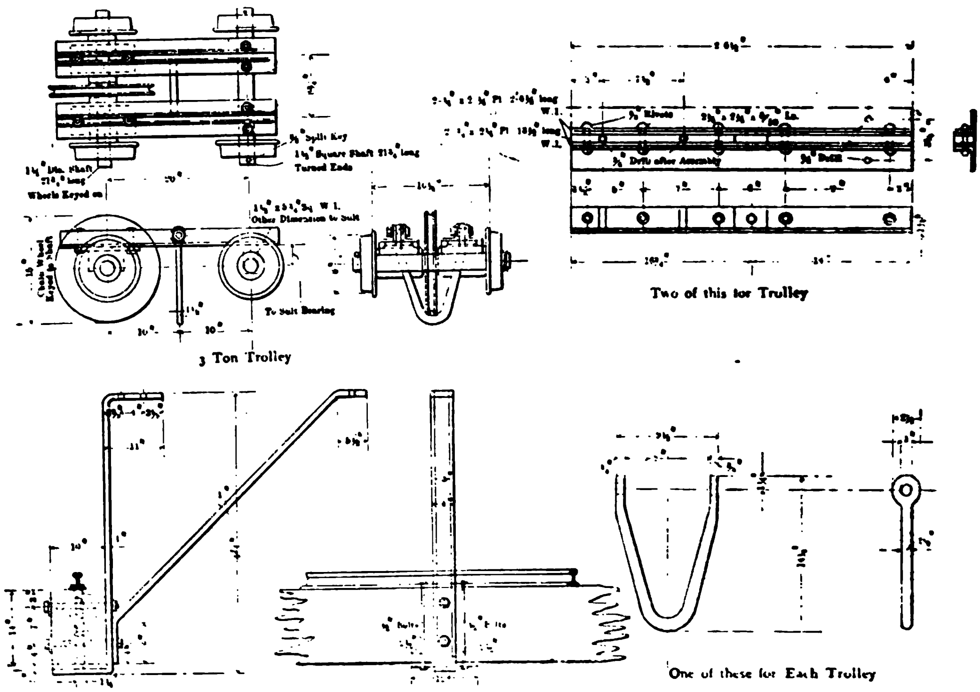


FIG. 2 DETAILS OF CRANE.

in a space of 3 feet below the truss. We took up a little more than that with the camber rods, but kept within a very satisfactory limit, and the crane works very smoothly, both the bridge and trolley moving easily under load, the heaviest load being an 18-inch lathe with about a 12-foot bed.

E. J. H.

Chain Design.

In working iron bars up into a chain, it is easy to see that the longer each individual link, the less will be the number of welds, and the cheaper the resulting chain in first cost. It is sometimes claimed that each weld is a source of weakness, and that the chain containing the least number will be the stronger. This is not true, for the longer the link, the greater will become the knuckling action at the ends when going over sheaves and pulleys and the larger the sheaves must be if the chain is to work upon them without undue wear.

The following rule is a good method for determining the safe working load of a chain; D = diameter of iron in eighths of an inch; $D^2 \times 0.111$ = safe load in tons. This gives for a ¾-in. chain a working load of $6 \times 6 \times 0.111 = 3.996$ tons.—*Compressed Air.*

Uses of Graphite.

Graphite is used for making refractory crucibles, stove polish, foundry facings, paint, and lead pencils; as a lubricant, and in powder glazing, electrotyping, and steam packing.

For the making of crucible crystalline graphite is required; the fibrous or lam-

d variety is used, because its supe- binding qualities add to the strength he crucible. The quantity of the ral used for making lead pencils is paratively small, but the quality be of the best. For use as a lubri- a high grade of the crystalline pro- is essential. But material of an in- r grade is employed in the manu- re of stove polish, of foundry fac- and of graphite paint, which is to protect iron work (as in smoke- s, iron roofs, elevated steel struc- , etc.) While crystalline graphite d to some extent, its special proper- are not absolutely required, and the amorphores variety, both na- and artificial, is largely employed hese purposes.

parison of Cost of Concrete and Stone Masonry.

e cost of concrete and stone ma- varies largely with the local con- s and the character of the work hich they are used; but there are few places where concrete masonry only cheaper than stone masonry, better, being much stronger and suitable in many ways. This fact oming more generally recognized, more than one quarry which in for- years produced building stone is producing crushed stone for con- The following figures give a gen- lea of the comparative cost of brick ry and concrete, per cubic yard:

BRICK.

ick	$3.75
rel cement	1.50
d sand	.50
	.25
ing a total	$6.00

CONCRETE.

el Alpha cement	$2.00
½ load sand	.50
Broken stone	1.50
Labor and forms	1.50
Making a total	$5.50

—*Scientific American.*

Correspondence.

E. B. Hayes' reply, in a social way, to Mr. Lincolnite sounds very reasonable to any one who has had any dealings at all with the colored man. And as to the commercial side of the subject, can give this example: A well-known automobile factory was giving $65.00 per month to a colored graduate of a prominent technical school when not another one of the class was receiving less than $125.00 per month.

Efforts to defend correspondence schools, so long as Scranton solicitors are with us, is obnoxious to all of us. Is it any wonder men are insulted when they apply many places for work when everywhere solicitors are collecting money they know will never make "a silk purse of a sow's ear?"

Hampden County Draftsmen's Association sounds innocent enough. Have they been told by the Manufacturers' Association that a part of the duty of the manufacturers is to *whip* certain shops into treating their employes in ways intended to keep men? Such is the word passed around here, but one of the places can't get draftsmen of the kind they want yet.

It seems that in four years Mr. Browning should have been able to prove that a draftsman's paper can not be made profitable, though there are enough and to spare, men in the trade to have given him a subscription list that would merit any advertiser's attention.

As the man at the board going over a file of Browning's Industrial Magazine, the following can be offered:

Why must a ninety-men drafting room ask fifteen minutes over forty-eight hours for a week's work? That quarter of an hour strikes many ones who do not watch the clock either, as an index of the treatment one must expect in working for the company.

Fort Worth's E-Raiser must hold our heads as a machine able to do the same work any hour of the twenty-four we run it: that is, if he is where he must "make a showing," but if not, only one of the rest of us laying over a board, let his argument be for per hour wages and then see how little overtime is *necessary*.

Vox Populi must be a fighter and as such should crowd his way into pleasant places as have some "fierce" draftsmen we know. Though a fighter he is not Irish, but English or else he would understand our American slang, which is *good* because it condenses in a few words what would take a waste of words to describe. Not being in "the muck-raking business" will have to let his personal remarks pass.

Rules of Practice have no terrors save to the poor letterers and it is often wondered if the big office at East Pittsburg expects a draftsman to make letters according to standard: is the reason they are always hunting for men? What a thinning out there would be of the ranks if a man had to make his lettering as correct as the views and dimensions!

T. C.

Engineering Review.

The Constitution of Hydraulic Cements: a paper read at the XXIX annual meeting of the association of German Portland Cement Manufacturers at Berlin, Germany, by Dr. W. Michaelis. This article in June issue of *Cement and Eng. News*, comprises over nine pages of formulae and descriptive matter.

The excellent article on air furnaces by Ralph H. West, in *The Foundry* for August is so well illustrated that every designer should have a copy if he would be posted on this class of melting furnace.

Metric System for Buildings.

Change to the French System of Weights and Measures Favored by Many Managers, Architects, and Contractors.

Many well know building managers throughout the country have been interviewed recently by the New York Herald in regard to the possible adoption of a metric system of measurements for buildings. Among those interviewed were: Thos. A. Hall, president of the Building Managers' Association of Chicago, S. G. McMeen, a Chicago Consulting Engineer and Henry F. Hornboshl, who planned the buildings of the Carnegie Institute in Pittsburg.

The conclusions of the New York paper, based upon its interviews with those most directly interested in building problems, are expressed as follows:

"Builders, constructors of great piles of steel and masonry which have of late years been reared in New York, as well as those engaged in erection of dwelling-houses, are heartily in favor of the adoption of a metric system of measurements. Beginning with the architect, the draughtsman, the maker of structural iron work, and including the mason, carpenter and plumber, all engaged in construction of houses believe they will be saved much unnecessary and foolish figuring if Congress will pass a law making the use of the metric equivalents compulsory in this country."

A FAMILIAR USE OF A LOCOMOTIVE CRANE.

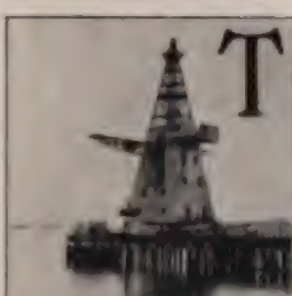
A Brown Hoisting Machinery Co. Crane Handling Coal from Barges in the Ohio River to Stock Pile in the Yards of The McKeesport Tin Plate Company, Pittsburg, Pa.

Browning's

Industrial Magazine

VOL. 5 OCTOBER, 1906 NO. 10

Coal and Ash Handling Machinery.



TO handle the fuel and the ash from furnaces for heating be they for home or for power has always been a problem of more or less importance.

As the form of furnace and its size, too, progressed from the hand fired to those of mechanical stoking the problem has grown. In the early days of hand firing the fuel was thrown into the furnace with a shovel, if it was small, and the ash removed with like instrument and carted away in a wheelbarrow.

And these are in so general use today they must be classed not only as the "pioneers" but as the "stayer" in the manner in which coal and ashes are handled.

The coal was dumped into the boiler room as near the furnace doors as possible or in the nearby yard for the space before the boilers was sometimes rather meager.

Next came the boiler room cars, for bringing coal from the yard or storage bins to boiler but they are filled by hand, moved by hand and either dumped or left standing before the boiler until unloaded.

They are also used for the transfer of ashes.

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They are also used for the transfer of ashes.

As the plants became large enough to supply large power units the problem of the economical stoking and handling of materials faced the designer and the result is some of the most automatic machinery ever produced.

The location of power plants in suitable position is often a difficult matter when accessibility in regard to fuel, water and labor supply are concerned.

To make the machinery labor saving has been the aim of every designer and will be seen in the large plants that this has been done.

With conveyors, storage hoppers, automatic weighing machines, chutes, gates and mechanical stokers little need of labor is seen in a mammoth boiler plant of today. Then machinery for handling coal and ashes is confined to the larger plants although an ash conveyor may be often found on a hand filled mechanical stoker plant of 250 horse power.

The fuel problem is a large one in a great many plants today and the handling of it before it arrives inside the boiler room should be considered together with the latter.

THE GAFT, BUCKET AND CAR SYSTEM

Handling coal to stock pile from barges. Installed by the Robins Conveyor Belt Co., New York.

The fuel bill is not the price per ton f. o. b. the plant but includes all expense of handling it between the cars or boat and the fire-box and to this should be added the cost of removing the ashes.

Since the weight of the coal is about fifteen times that of the ash, it is cheaper to haul ashes than coal, thus it is more necessary to be near the coal supply than the ash dump.

SPECIAL HOIST FOR HANDLING FUEL TO OVERHEAD BUNKERS.

In power plant of Milwaukee Elec. Ry. & Light Co., Milwaukee, Wis. The crane was built by Pawling & Harnischfeger, Milwaukee and the wagons designed by C. J. Davidson, of the power company.

Some managers prefer to be on the safe side by providing coal storage yards and rehandle the fuel, rather than rely on the railroads to supply regularly to the conveyors to large hoppers above the boiler.

These hoppers deliver the coal to the stokers or to the floor before the boilers through chutes fitted with suitable gates.

Chutes should be designed to avoid choking and the gates should be hard to open but easy to close so to avoid a rapid flow of coal.

Let the manner of firing and handling inside the plant be what it may the storage outside is very desirable.

If near a water-way where boats can tie up loaded with coal a very suitable arrangement is the hoist, grab bucket and cable railway.

In one power station the coal is handled from the hold of the vessel to a storage building 800 ft. distant and rehandled by a conveyor to the boiler furnaces at a total expense of 3½ cents per ton.

As any amount of power, strength and flexibility can be obtained it is exceedingly well adapted for situations where there are heavy grades or where many changes of curvature in the line are necessary. The track is from 21" to 24" gauge and the curves are often built 12 ft. radius, thus enabling the track to reach every part of the yard or building.

TRIPPER FOR BELT CONVEYOR OVER BUNKERS

GANTRY CRANE FOR HANDLING COAL TO STORAGE.

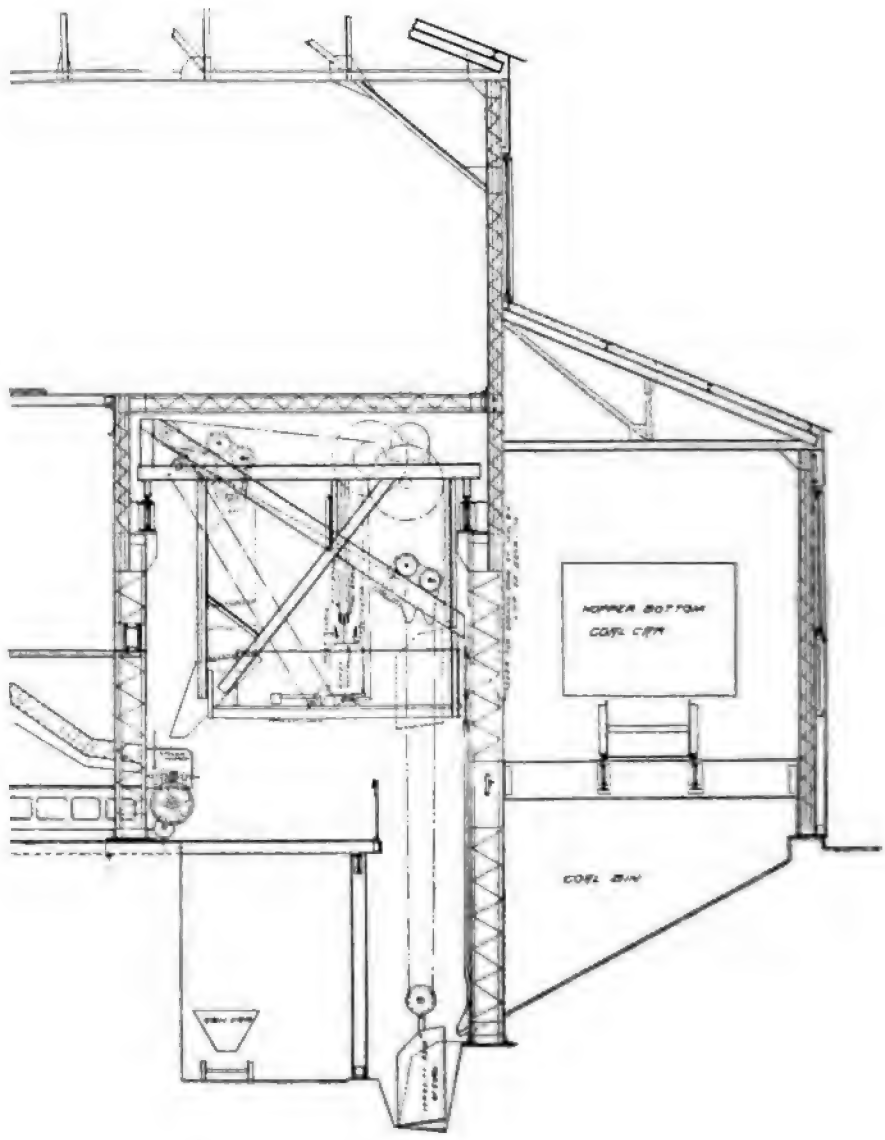
Crane was installed by the Northern Engineering Works, Detroit, Mich., at a central heating plant, and has a capacity of 30 to 60 tons per hour. Span 45 feet. Overhang, 18 feet on one end and 8 feet on the other. Capacity 2 tons with 1 1/2 cu. yd. bucket. Bucket hoist 60 to 130 feet per minute. Bridge 300 to 350 feet per minute. Trolley 100 to 150 feet per minute.

Continuous cables are often used to which the cars are gripped at any point and are drawn along the tracks until the grip is released or the railway may be built to form a continuous loop, and the car passes over the entire route automatically dumping at any desired point. The cable may be drawn back and forth by a reversing engine or by a winch driven by motor or shafting.

The cost of handling material by a continuous automatic railway is very small, the distance having very little to do with the expense. The cost is principally in loading the cars as the workman does not accompany them.

The cars run the whole length of the track and dump automatically wherever set and return to the loading place, thus reducing the cost of carrying the coal to the expense of loading the cars and cost of power to drive the cable.

The handling of coal to storage by an overhead bridge and a grab

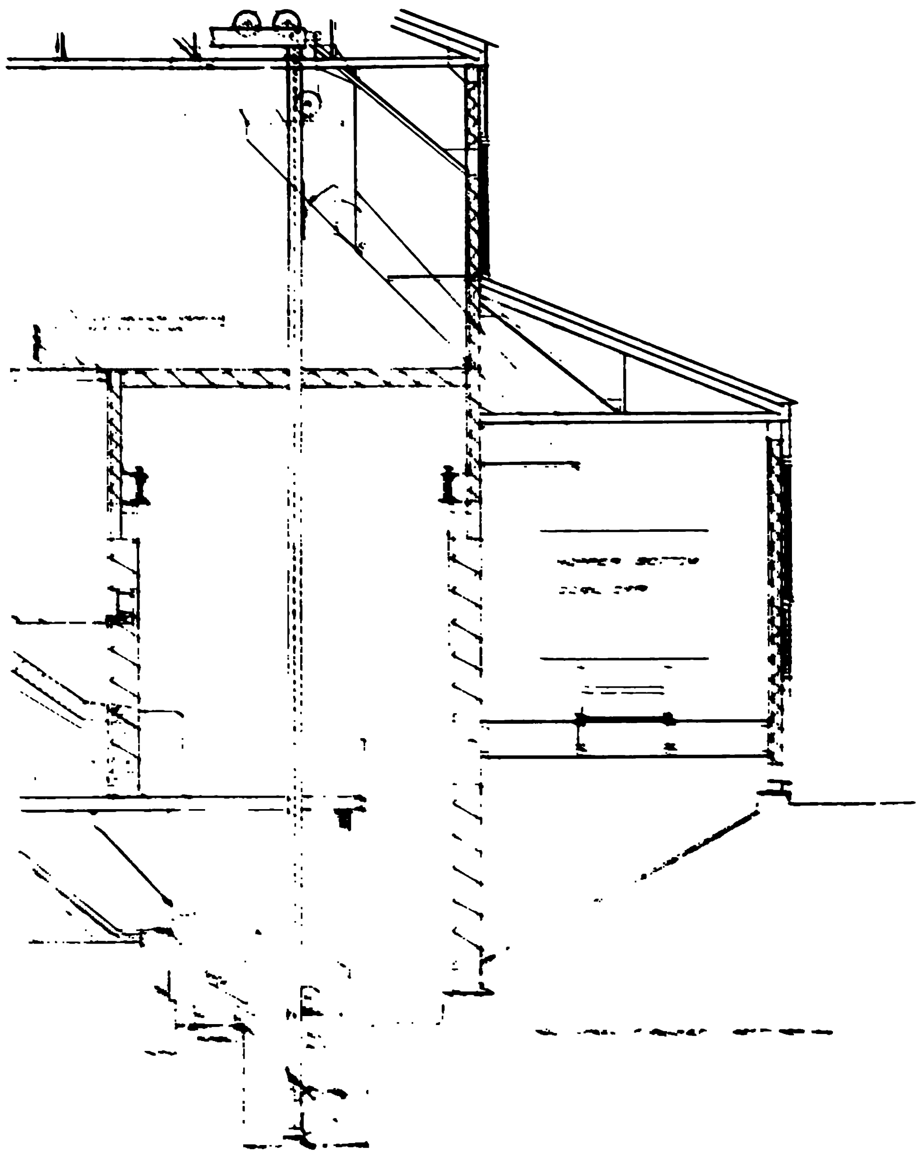


TRANSFER CRANE FOR HANDLING COAL.

Bucket is hoisted and run up the incline and dumped **into the hopper to the stoker. Crane speed 300** feet per minute. Hoisting speed of bucket. **40 to 80. Built by the McMyler Mfg. Co., Cleveland,** O., for Howard Axle Works, and considered **sufficient for 10,000 H. P.**

COAL STORAGE BINS WITH OVERHEAD DUMP

The whole structure is thoroughly braced to overcome the pressure of the coal.



ASH HANDLING MACHINERY OF THE HOWARD AXLE CO.

[illegible]

bucket is always a special problem, to be solved by a careful consideration of the local conditions. It is, generally, an expensive plant in first cost, but is quite satisfactory so far as the cost per ton is concerned.

Electric motors are well adapted for these plants, especially when a

COAL HANDLING SYSTEM AT SYRACUSE LIGHTING PLANT.

Designed by the Robin Conveyor Belt Co. with a Brown Hoisting Machine Co. crane and Hayward bucket. Radius of track 80 feet. Electric power to crane, which has capacity of 7000 lbs. at 40 ft. radius of bucket. 16" belts used for conveyors.

grab bucket is used, as they are free from the troubles that arise from steam and water pipes necessary for steam operation.

Few locations are so isolated that electric power can not be had that designers are generally safe in deciding on its use.

The designer of a large power plant should keep in mind from the beginning the necessity of sufficient head room if bunkers and conveyors are to be used.

This is essential in view of the fact that walks are required along the path of the conveyor which should be horizontal if any distance is covered so to keep coal of all hoppers on a level by hand trimming.

Incline runs are undesirable with scraper and bucket conveyors and impracticable for belts unless less than 22 degrees.

Scraper conveyors are wasteful of power and not to be recommended because of great friction of the material against the sides and bottom of the trough.

STORAGE YARD OF SCIOTO VALLEY TRACTION CO.

Complete coal and ash handling machinery built by the Jeffrey Mfg. Co., Columbus, Ohio

ASH ROOM IN BASEMENT.

Scioto Valley Traction Co.

No conveyor is more suitable to vertical lifts than those with buckets, but belts have been used to elevate to considerable heights by using a series of inclines. As far as power is concerned the belt conveyor is the most economical for horizontal runs.

With either type of conveyor over the bunkers automatic trippers must be provided and in the case of a belt it should be movable.

The trippers may be either "hand driven" or "automatic," the former being moved from point to point by means of a hand crank.

The "automatic" is propelled by the motion of the conveying belt and it reverses its direction at each end of the run so to distribute the material evenly.

Though this is done, some hand trimming of the coal in bunkers is sometimes needed. Trippers have no serious effect on the belt for several cases are cited where belts are in use after five years of continuous service. For handling ashes with a belt it must be good material and it

has been found pure rubber is entirely unaffected by the sulphurous acids which are in all coal ashes and which have a strong corrosive action on iron and steel.

A 10-inch Robins belt carries the ashes produced at the Ninety-sixth St. Power Plant of the Metropolis St. Ry. Co., New York. This plant has a capacity of 70,000 horse power and the ash problem is a serious one. This conveyor has been in use for six years and is in excellent condition.

A locomotive crane may be used to advantage in handling coal from storage pile to conveyor chute or into small dump cars. An illustration of a locomotive crane is given showing its range of action with a system of conveyors. The cost of operating a locomotive crane for handling [illegible] \$8 a day, which includes engineer, [illegible] interest.

[illegible] bucket [illegible] handle from 880 [illegible] cars on parallel tracks in [illegible]

[illegible] hoppers and conveyors [illegible] to consider. If a

[illegible]

large supply is to be retained at all times great strength of building must be provided.

A very interesting coal and ash handling plant is that at the power house of the Scioto Valley Traction Co., Reese's Station, O.

All incoming coal is brought in cars to a track over a pit with one hoppered side and thus slides out where it can be reached with a grab bucket. A bucket of 48 cu. ft. is used to carry coal from car or pit to bins over boilers or to stock pile.

BOILER ROOM, SHOWING TRAVELING HOPPER OVER STOKERS

Scioto Valley Traction Co.

Immediately over the fire room and in the center of the building longitudinally, is a bin which holds two cars of coal. This bin is of armored concrete construction and provided with two discharge gates in its underside, fitted with valves controlled by hand.

These gates discharge into hoppers which travel on a runway extending along the front of the boilers and serve the stokers.

These traveling hoppers are provided with motors and their move-

ment along the runway is controlled from the floor of the fire room through pendant chains attached to the controller.

These hoppers are run under the storage bin and filled with coal, which is carried by them to the stokers and distributed.

Over the storage bin is placed a hopper made of 2x½ inch bars, 1½ inch apart. This hopper discharges onto an inclined headed flight conveyor five feet between centers and 30 inches wide leading to a Jeffery 24x30 inch coal crusher driven by a 20 H. P. motor.

All the coal used in the entire plant is discharged onto the diamond screen or grizzley; that which is of the proper size and all fine coal falls through the bars into the storage bin; these lumps which are too large are carried by the conveyor to the crusher, by which they are reduced to the desired size and from which the crushed coal falls into the bin.

For the storage pile back of the boiler house, a steel trestle has been built which supports the runway. The trestle is 150 ft. long, 50 ft. high, 30 ft. wide at the base and spans the ash pit and the one into which the coal is dumped from the hopper bottom cars.

The storage space is 120x30 ft. in which 1,000 tons of run of mine bituminous coal can be stored.

The runway also extends into the building over the diamond screen. The storage space is covered with concrete and is well drained.

The bucket will hold 2,400 pounds of lump coal and 3,000 pounds of screenings and is operated from a trolley which traverses the runway over the pit and storage pile.

The trolley is equipped with two slow speed D. C. crane type series motors, one of 25 H. P. for hoisting the bucket and one of 5 H. P. for traversing the trolley.

The cost of unloading and distributing coal by this method with labor at 15 cents per hour and current at 2 cents per K. W. per hour, is as follows: Unloading from cars and placing directly into the bin, one cent per ton; unloading from car and placing in stock pile, 75-100 cents; taking ashes from pit and placing into car, 8-10 cents per ton.

The bucket will take 99 per cent of the coal in the car, leaving only one per cent to be handled by hand.

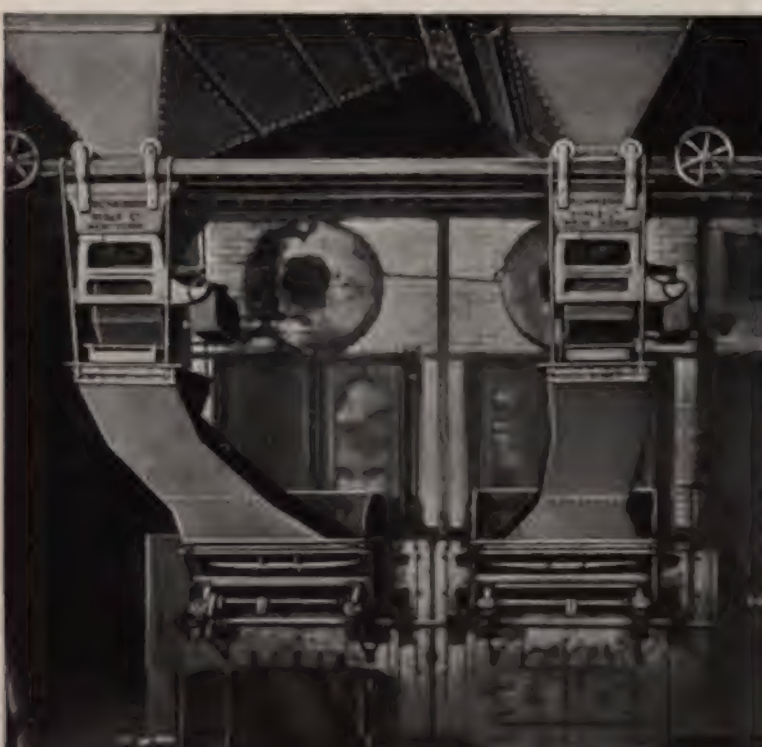
The ashes fall into hoppers which extend into the basement and are dumped into a cart and wheeled to the pit where they are hoisted to cars by the grab bucket.

The pit will hold about five car loads of ashes.

Practically all managers of power plants are alive to the necessity of a record of the boilers' performance, and the weighing of coal—and too, — is carefully considered. This type of machinery is

very interesting to engineers all over the Union not only in connection with power plants but for equipping railways, and in fact every plant where it is desirable to keep an accurate check upon coal weighed to cars or barges to storage; to automatic stokers and to boilers.

As we have received numerous inquiries regarding such equipment, inquiry on our part develops the fact that this type of automatic scales is of the simplest possible construction; operated entirely by gravity of the falling material when same is free running, flowing down an angle of say 45 degrees. On a product which is damp, or for any reason likely to clog the scale, the Company furnishes a patent agitating device, requiring only slight power to operate it—the same can easily be operated by a foot lathe. All machines are fitted with counters which automatically register every dump of the scale; and by the use of this apparatus the engineer is able at all times to decide as to the best quality of coal for



RICHARDSON WEIGHING MACHINE.

Used in the Fourteenth St. Pumping Station, Chicago.

his use, also to trace any negligence on the part of firemen. This feature of the scales was the means of locating for the engineer, at the above station, a heavy loss in coal fed to one boiler due to the carelessness of one of the firemen. The economy secured by the use of this machinery has induced many to install it.

All these scales show an absolute balance of every weighing.

The accuracy of the machine may be determined at any time by simply removing the weights and balancing the empty hopper. This accuracy is always assured when the machine is properly erected and adjusted and the coal conforms in size to that specified for the size of scale. Given the size coal specified for each machine, the company guaranttee to weigh within 1 per cent.

They also claim that the discharge from the hopper will not cause it to vibrate, injuring the delicate knife edges. The Richardson is said to be the only automatic scale entirely free from such vibration.

It is said that they can be installed in less height than any other automatic scale of the same capacity.

They are made in various sizes, weighing from 100 lbs. per dump, up to 6,000 lbs. They may be constructed to weigh up to 6 tons.

The scales are made stationary, movable on wheels or overhead rails.

UNLOADING TOWER [illegible] ETC.

The Use of Locomotive Cranes.

By W. H. Waite.

OF the many modern devices for the rapid and economical handling of material, few, if any, have exceeded the locomotive crane in growth and effectiveness. Practically unknown a decade or two ago, except in very large plants and on wharves for unloading ocean steamers, the locomotive crane was considered somewhat of a luxury. But it has been so perfected, simplified, and reduced in cost that, today, it is a modest business indeed where a crane of some size cannot be used to advantage.

Before going into any description of the various uses to which a locomotive crane can be put with profit, it might be well to define just what kind of a machine is meant by this name. A locomotive crane is, broadly speaking, a self propelling car, capable of running on a railroad track (of various gauges) and equipped with a boom or a derrick by means of which the load can be picked up and deposited anywhere within the length of the trackway and on either side of it within the reach of

FIG. 1. AIR CRANE HANDLING COAL.

the boom. On the car is mounted the machinery for hoisting the load, swinging it from side to side, and for propelling the car along the track in either direction.

A locomotive crane differs from an overhead traveling crane by being able to run on a surface track and so is not confined to any particular runway. As usually built it is a very effective switch engine, capable of hauling a number of loaded cars.

While originally used only in large operations around steel and iron plants and the like, locomotive cranes are now to be found in almost every class of work; handling stone in rock quarries and yards, digging sand and foundations, handling coal in power plants and storage yards, coaling locomotives and cleaning ash pits, piling logs and timber both in the forest and at the mill, and what not. Every day finds a new use for them.

The locomotive crane for industrial purposes, considered apart from the railroad or wrecking crane, is built in sizes ranging from 1,000 to 40,000 pounds maximum capacity, and with a reach of up to forty or fifty feet on each side of the center line of the track. They are operated by steam, electricity or compressed air, and in some few cases by hydraulic power.

FIG. 2. AIR CRANE TRANSFERRING LUMBER.

The steam operated cranes are by far the most popular, as they are entirely self contained and so are independent of local conditions. The electric and air driven cranes are, of necessity, limited in their range to that covered by the conductors. Air can, of course, be stored in tanks on the crane and charged at a central station, but even then they have by no means the range of the steam crane.

Taking the cranes in order of their size we have, first, the small air machine illustrated in figs. (1) and (2). These are built with capacities of from 1,000 pounds to 10,000 pounds and a lift of about twelve feet at a fixed radius of seven to twelve feet. They are not strictly locomotive cranes as they are not self propelling but can be easily pushed from place to place by hand. The air is supplied at about 80 pounds pressure through pipes laid around the grounds and provided with outlets at convenient points to which the crane is connected by rubber hose.

The cranes are equipped, as shown, with an air cylinder at the foot of the boom acting directly on the hoisting cable, and also with a cylinder in the base, by which the upper part can be swung around through a full circle on a ball bearing turntable. The air for the hoisting cylinder is ad-

AN ELECTRIC LOCOMOTIVE CRANE HANDLING CASTINGS.

short mast and trolley poles. Crane built by the Brown Hoisting Machinery Co., Cleveland.

BROWN HOISTING MACHINERY CO. ELECTRIC CRANE WITH HIGH MAST.

[illegible]

[illegible] center pin. [illegible] material has to [illegible] instance, a case [illegible] being used to unload [illegible]

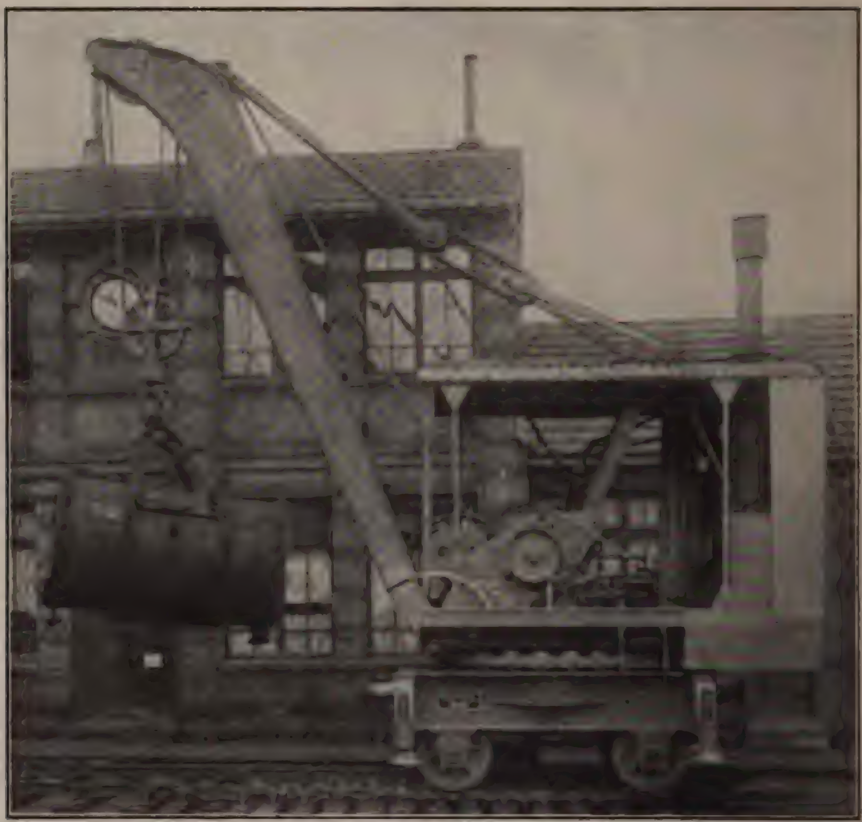
[illegible] has over six miles of [illegible] cranes, they [illegible] loads and [illegible]

[illegible] as stated before. [illegible] advantages. [illegible] there is no danger [illegible] unquestionably [illegible] water tanks [illegible]

[illegible] already in [illegible]. The

LOCOMOTIVE CRANE HAULING CARS AND LIFTING LOADS.

Dismantling a portion of the sheds at St. Louis Furnace, loading on cars and hauling away to storage yard. A Browning Engineering Co. crane, 10 tons capacity at 10 ft. radius.



STEAM LOCOMOTIVE CRANE OF FOREIGN DESIGN.

Twenty ton crane with hoisting speed of 118 feet per minute, and traveling speed of 200 feet per minute. Hoisting, rotating and traveling are independent of each other. Built by Cailland & Co., Havre, France.

the advantage of conforming with standard practice, and have given very satisfactory service.

With the overhead trolley, however, there is always a chance of striking the wire with the boom and the maximum height to which the boom can be raised is thus fixed at a comparatively low point. And while the third rail system is free from this objection, it is troublesome in the laying of switches, crossings, etc., and will not permit of a casting being laid across the two rails.

Some cranes have been provided with a drum fastened to the lower base, or car, of the crane, upon which a quantity of electric cable is wound. Contact is made between the crane and generator by plugging the end of

the cable into suitable stations arranged at convenient points in the yard, and the drum is provided with means of taking up or paying out the cable automatically as fast as the crane goes backward or forward.

A very ingenious arrangement is in use in the yards of the Link-Belt Co., Nicetown, Pa., where the current is carried to posts placed at the side of the track, but far enough from it to safely clear a car. Each post is high enough to reach to the top of the lower base of the crane and carries a negative and positive pole. Contact is made between these and the crane by means of two parallel bars, fastened to the lower base in such a manner as to be always pressed against the poles. The posts are set close enough together to insure contact with at least one post continually.

Locomotive cranes are commonly rated by their lifting capacity at 10 feet radius from the center line of the track. Thus, a standard 15-ton crane will lift a load of 15 tons at a distance of 10 feet from the center line of the track, and will also swing it around through a full circle and carry it from place to place along the track. All three operations—hoisting, swinging and traveling—can be done simultaneously. The

LOCOMOTIVE CRANE LOADING IRON ORE.

Wellman-Seaver-Morgan Co. builders.

[illegible]

THREE BROWNING ENGINEERING CO. CRANES HANDLING COAL.

lifting capacity decreases, of course, as the boom is lowered and the reach becomes greater, until at 40 feet, the usual maximum reach, the 15-ton crane will only lift about 2½ tons These figures are based upon the cranes working on a track having a standard, or 4' 8½" gage

Various devices are made to increase the capacities of locomotive cranes when working with a long reach, but they should be used only when absolutely necessary, as none are entirely satisfactory. The method most employed is to fasten a large counterweight to the revolving part of the crane, the usual way being to hang it under the boiler. This has a serious disadvantage, however, in the fact that, should the load be suddenly dropped for any cause, the crane is liable to be tipped over backward.

Another method and the most effective where it can be used, is to provide the crane with extra wheels running on a wide gauge track. These stability wheels are about three inches smaller in diameter then the regular gauge wheels and are pressed on the ends of the same axles.

which are made long enough for the purpose. The wide gauge track is laid only at the place where the extra heavy loads are to be lifted and have the rail heads about two inches higher than those of the regular track, with the ends depressed enough to bring them down to the regular level.

Ordinarily the crane runs on the standard gauge, the small diameter of the "stability" wheels allowing them to clear the regular track at crossings, etc. But when the wide gauge track is reached the stability wheels come into use, raising the crane entirely off the inside rails. This, of course increases the leverage of the body of the crane and so enables it to pick up just that much greater load at the end of the boom.

Still another way is to equip the crane with outriggers extending several feet each side of the car and having the ends provided with jack screws that rest on blocking. Of course their use is restricted to places where the load does not have to be moved along the track. When not in use the outriggers are pushed under the body of the crane out of the way so that they do not interfere with its regular use.

The boom of the crane can be made in various lengths and shapes to suit the purpose for which it is desired. By equipping the crane with a double drum, a clam shell or orange peel bucket can be used. The double drum does not interfere in any way with ordinary use of the crane.

The accompanying illustrations will give a good idea of the many uses to which one of these machines can be put.

Industrial and Portable Track.

AS the name implies, these tracks are used for all kinds of industrial purposes, either to remain permanently placed or to be shifted around, as the work may require. Their main advantages are light weight, stability and resistance, and the fact that the ground on which they are to go needs, in many cases, no preparation at all; in other cases, only very little. Their usefulness is today so well recognized by all that nothing further need be said. Every up-to-date contractor uses them; for instance, for carrying concrete and building materials, etc., instead of the heavy second-hand standard railroad rails of former times. They are in use in mines, plantations, factory yards, buildings, etc., and everywhere else where material has to be transported, either temporarily or permanently. They occupy very little space, can be laid quickly by any ordinary workman and permit reaching points and corners, which without them would be inaccessible, thereby saving both time and money, and

CARS AND LOCOMOTIVE HANDLING FOUNDRY SUPPLIES.

Built by the C. W. Hunt Co., New York, N. Y.

avoiding trouble and annoyance, and systematizing the work from beginning to end.

Of course, while the principle always remains the same, the details of construction vary to suit circumstances. A contractor, for instance, handling a few tons of concrete, several thousand bricks, etc., for a short time during the construction of a building, does not require the same equipment which would be used in a factory where heavy machinery, raw and finished material is being constantly transported from yard to shop and from shop to warehouse. And the sugar plantation which carries

THE SIDE DUMP CARS USED FOR COAL, ASHES, ETC.

the [illegible] many miles of railroad cannot use the [illegible] carrying coal and ashes in power plants, [illegible] and narrow shafts of a mine.

[illegible] the installation of a railroad is thought [illegible] The [illegible] rail sections, say from [illegible] to carry under proper conditions and [illegible] ton of [illegible] each 10 lbs. of [illegible] if the car itself weighs 10 tons and

has 8 wheels, and carries a load of 20 tons, the weight to be carried on the rail is 30 tons on 8 wheels, or nearly 4 tons on each wheel, so a rail weighing at least 40 lbs. per yard should be used. The carrying capacity of the lighter rail, under 25 lbs., cannot be calculated by the same rule, because in the first place they are designed on different principles, and in the second place they are used under different conditions. The capacity of these light rails depends to a much greater extent (than that of the heavier ones) upon the conditions under which they are used; the ground, the kind of floor, distance between ties and many other items, which must all be taken into consideration. To give an approximate idea, the following can be taken as standard for a 4 wheeled car:

Rails weighing per yard—	Carrying capacity.
8 and 9 lbs.	2 to 3 tons
12 "	2½ to 4 "
16 "	3½ to 5 "
20 "	4½ to 8 "

These loads are based on careful calculations, for rails that have been in use, with ties 3 feet between centers and for continuous or ordinary use. The rails occasionally will stand a heavier load; under favorable condi-

ELECTRIC LOCOMOTIVE AND INDUSTRIAL CARS.

Built by C. W. Hunt Co.

tions even the maximum loads can be increased; in short, the above capacities are only a general average.

The second question is that of the gauge of track. This is of the greatest importance, as on it depends very often the success, financial and otherwise, of the road. The standard wide gauge of most countries is 4'-8½" (1435 mm.), but there is no standard narrow gauge, each manufacturer, each country or even each branch of industry having a different one, so that a prospective user of an industrial railroad is generally very much at sea to select the proper gauge. If the gauge is wide, the road is very expensive to build, requiring longer ties, more ballast, wider bridges, etc., and on account of the greater width required, may not be built in places where a narrower gauge could easily be used, and consequently the road would lose much of its usefulness. In reference to the cost of building roads it might be stated here, that all other conditions being equal, the cost of building a road of 36" or 1 meter gauge is about 40 to 50 per cent higher than for a road of 24" gauge. If the gauge is too narrow, it cannot handle the quantity of freight, and is therefore of little use. It has been determined in actual practice that for most industrial purposes the gauge of 24" is most practicable, because it combines lowest first cost with greatest efficiency, and has many of the advantages of wider gauges with all the benefits of a narrow gauge, and allows the running of cars of sufficient width to take care of all requirements of an average industrial railroad. It is for this reason that nearly 90 per cent of all such railroads are built for this gauge, and it is recommended strongly, as it is being recognized as the standard of narrow gauges. A narrower gauge should only be used if the space is limited, as for instance, in mines, very narrow buildings, etc.; a wider one, only if the traffic is very heavy, or very wide cars are needed, or where the locomotives are so heavy and large that they cannot be built for that gauge, or, finally, if the road is connected or is to connect with roads of another gauge. The Ernst Wiener Co. of New York say: "We have made 24" our standard narrow gauge, but also keep in stock material for 18", 20", 30" and 36" and can manufacture equipment for any gauge of track, including tracks that require outside flanged wheels."

The next question is the connection between the rails. In most cases the regular fishplate connection will answer the purpose. If, however, the tracks are not to be kept in place any length of time, but will require frequent change of location, it is better to use a connection which will not require bolting, but will, nevertheless, connect the rails satisfactorily, such as light angle plates, angle shoes, etc.

Automatic Cableways.

BY FRANK C. PERKINS.

BY MEANS of modern labor-saving devices the cost of transporting materials is at the present time reduced to a minimum and the time required for moving ore, coal, and other materials is greatly reduced by the use of automatic aerial wire rope tramways. The accompanying illustrations show the automatic system of the Vulcan Coal Co. at Vulcan, W. Va., as well as that of the Mohican Brick Co. at Sandy Hill, N. Y.

The accompanying illustrations also show the cableway from Kings Mines, Ohio, to the locomotive coaling station constructed for the Baltimore & Ohio R. R., by the Brown Hoisting Machinery Co., of Cleveland, Ohio. The coal pocket is filled by the Brown Hoist cableway from the mine and the locomotive is shown taking coal from the gravity bottom

AUTOMATIC TRAMWAY SYSTEM.
The Vulcan Coal Co., Vulcan, W. Va.

dumping tub. These tubs are constructed of steel of box form with two bottom doors hinged at opposite sides which open after the tub has descended to a fixed point, dumping the coal at a central point on the tender, the position of the doors when open preventing spilling of the coal. These tubs are counterweighted when empty in such a manner that the counterweight pulls them back again into position to be filled again, while the filled tubs, being heavier than the counterweight, descend slowly under the perfect control of the operator, who releases them by pulling on a pendant hand chain. By simpy pulling on this chain and releasing the tub, they automatically descend, dump, return and lock themselves in their former position again being ready for filling, this being done by one of the operators moving a proper valve for the purpose.

The coal pocket is constructed of steel and is of the suspended form, the sides and bottom of which take the natural lines of a filled bag suspended from two points, this form being one that economises greatly in the use of material in the construction. It is claimed that a pocket of this type requires 80 per cent less material than a steel pocket of the same

AUTOMATIC AERIAL CABLEWAY SYSTEM.

[illegible]

capacity and strength of other construction. The pocket is hung from girders supported on four steel posts which rest on stone foundations. It is covered with a corrugated iron roof, having sliding covers over hatches through which the coal is dumped.

In many mining districts the engineering difficulties encountered in building railways for the transportation of ore are so great and the cost of construction and maintenance so high that aerial wire rope tramways are utilized instead for transporting the material from the mines over great distances. The accompanying illustrations show the details of construc-

TOWERS OF AERIAL TRAMWAYS.

Used by North American Copper Co., Encampment, Wyo.

tion and operation of an automatic aerial cableway constructed at Encampment, Wyo., for the North American Copper Co., which is one of the longest in this country, passing over a watershed or continental divide at an altitude of more than 10,000 feet and having a total length of about 16 miles. This wire rope tramway was installed as the most economical means for bringing the ore from the mines to the smelter and was furnished by the A. Leschen Sons' Rope Co. of St. Louis, Mo. The total distance from the mines of the North American Copper Co. at Encamp-

ment, Wyo., to the smelter below is about 84,500 feet, and 800,000 lbs. of ore are transported each day of ten hours, the buckets each having a capacity of 0.5 cu. ft. The towers which support the cables are located at intervals from a hundred feet or more to over 2,000 feet. There are three long spans on the upper sections of this aerial cableway, varying in length from 1,800 ft. to 2,000 ft. In the building of this tramway construction camps were established along the line and the timber for the towers hauled from neighboring forests, the entire installation requiring about six months. The lower terminal of this cableway was installed

upper ter-
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delivered at the lower terminal of the second section it is allowed to fall into a large storage bin, the buckets being automatically discharged. In a similar manner the two lower sections are connected and by the aid of the large receiving bin either the upper or the lower sections of the cableway may be operated separately or at the same time. There are tension or anchorage stations provided at intervals of about 5,000 feet to care for the take-up and stretch of the track ropes. It is stated that the highest tower on this cableway is nearly 70 feet high, the elevation of the rope saddle being 9,993 feet above the sea level. The engines used for operating the several sections of the cableway are installed at the junction or transfer point and heavy beveled gearing is employed for transmitting the power to the automatic aerial wire rope tramways. The two track ropes are from 1 to 1.25 inches in diameter and are constructed of crucible steel. The empty buckets as well as the loaded buckets travel on these stationary ropes, being propelled by means of a traction rope about ¾ of an inch in diameter also made of crucible steel. The buckets are attached to the traction rope by means of a special clip and the shape of the flanges and grooves of the sheaves are such as to accommodate the shape of the clip on the traction rope so that this rope always rests in the sheave whether a bucket is passing over a tower or not, and a skip is used on the towers to guide the traction rope in the groove of the sheave in case it becomes displaced from any reason whatever. The buckets are attached to the traction rope by flat clips with a button shaped end by means of two forged bands which encircle the rope and have the lay of the rope forged in them. It is claimed that it is practically impossible for the buckets to slip on the line irrespective of the load or the grade on account of the positive hold the clips have on the rope, and the uncertainty of depending on friction or compression is avoided. To the bottom of the buckets, which hold a trifle less than 7 cu. ft., there is a pin attached which is used in connection with the automatic discharging devices at the unloading terminal. While the bucket is in transit the clip is engaged between the two trips but when the bucket reaches a terminal, one trip is dropped back allowing the clip to pass out of the housing and the bucket is thus detached from the cableway. The sliding frame is raised by a curved bar at each terminal and the trip is moved back. The bucket is also attached to the clip in a similar manner and the trips are locked to prevent opening. There are no attendants required as the entire operation is automatic. At the tension stations one section of the track rope is anchored to a tension take-up device while the other section is anchored to the ground. The travel of the bucket is not interrupted but passes by the tension station without difficulty, a rail connecting both sections,

while the traction rope is guided by sheaves at these stations. It is stated that the brakes for controlling the cableway are operated by levers in such a manner that a single operator can load the buckets from the chute as well as perfectly control the cableway.

Unique Use of a Derrick.

A derrick of the American Hoist and Derrick Co. used as a pile driver in a lagoon of the World's Fair, Chicago. One of the imitation ships of the Christopher Columbus fleet in the background.

INDUSTRIAL PROGRESS.

Smoke Prevention.

By F. L. Newell.

THE Automatic Smoke Preventer and Fuel Economizer which is herein illustrated and described, is manufactured and sold under the original Thomas and other patents, owned by the Automatic Smoke Preventer Co., of New York. The following will show the device is not new and untried; the increased use of bituminous coal and the attending complaints of smoke nuisance have caused the appearance of this article.

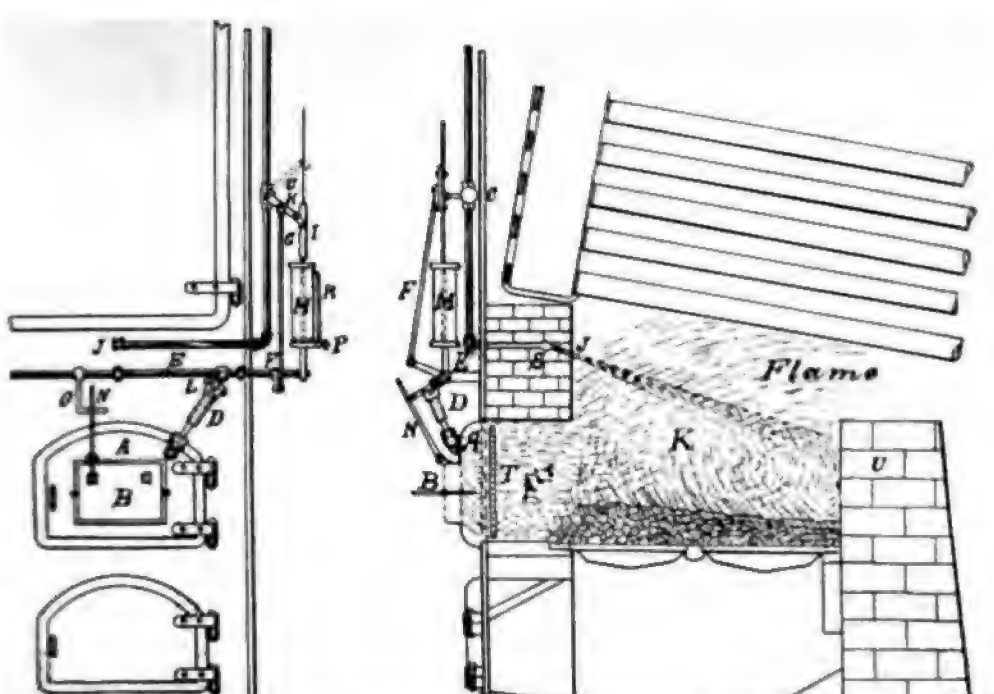
The first impression of the uninitiated is anticipated; this device is not to be classed with the many so-called smoke consumers and preventers, but is entirely distinct in construction, operation and principle of smoke elimination, also being automatic.

This device does not consume the smoke, but it so mixes the furnace gases with air automatically, that complete combustion takes place, with the result of high temperature and no smoke.

It is therefore easily seen that the device not only prevents smoke, but greatly increases the boiler efficiency.

It is inexpensive, positively prevents smoke or soot, saves 10 to 18 per cent in fuel account, is independent of fireman and requires no attention; does not reduce steam pressure when firing, requires no motive power whatever, costs almost nothing to maintain and meets all requirements of law and successfully burns low grade fuels, garbage, leather shavings and all waste without smoke or odor. This device does this and has done it for seven years and users must beware of subterfuges.

In presenting a brief explanation of this device for perfecting combustion in the use of



Thomas Automatic Smoke Preventer.

bituminous and other soft coals in boiler furnaces, we state unequivocally that the apparatus used actually accomplishes all that is claimed by the inventors, as may be found by reference to those that have been in use for the past seven years. This is accomplished by the timely introduction of heated air and superheated steam into the combustion chamber of the furnace. *It has never recorded a failure.*

COMBUSTION.

It is known, scientifically, that carburetted hydrogen and other compounds of carbon require great quantities of atmospheric air to effect their combination; yet no means have heretofore been adopted, practically, of ascertaining what quantities are supplied, and they have been treated as though no such proportions were necessary. It is known, scientifically, that the relative proportions in which the constituents of atmospheric air combine are definite, yet, practically all seem to have appeared wholly indifferent to the distinct nature of these constituents, or their effect in

Front view of 100 H. P. boiler with device attached.

combustion. It is known, scientifically, that the inflammable gases are combustible only in proportion to the degree of mixture and union which is effected between them and the oxygen of the air; yet, practically, people have not seemed to trouble their heads as to whether they have effected such mixture or not. These, and many other similar illustrations, exhibit a degree of carelessness in the past in the matter of utilizing fuel to its greatest capacity.

The complication which characterizes the burning of coal is both physical and chemical; physical, because an intimate mixture and a suitable proportion of the elements concerned are essential to the completeness of their combination; chemical, because unfortunately for the special object of the furnaces, which is to generate steam, the less important element, hydrogen, is precisely that which demands the preference and must have its share of oxygen before the demands of the staple element, carbon, can be satisfied. The steam without the

N. Y. Tunnel Co. Boilers all equipped, being fired.

air could not fulfill the purpose any more than air in quantity without mixture. The cardinal condition on which complete combustion of coal in boiler furnaces is effected is the quick and complete intermixture of the gaseous elements of combustion—the air and the combustible gases of the fuel.

AIR (OXYGEN) AND STEAM (AS A MIXTURE) BOTH REQUIRED.

The proportion which the gaseous or volatile parts of the fuel bears to that which is fixed and capable of complete combustion on a common furnace grate may safely be considered as one-fourth in the case of ordinary bituminous coal. The air for the combustion of this gaseous material cannot be introduced with advantage, either through the interstices of the grate bars, or by opening the door. In the former case the air is deprived of its

oxygen by passing through the solid fuel, and then only helps to carry off the combustible gases before they can be burned; and in the latter case, the air which would enter, by reason of its proportionate mass, would produce a cooling influence and could not by itself be conveniently mixed so as properly to support combustion of the gases.

The combustion of the gaseous materials of the fuel is best accomplished by introducing through a number of jets or small orifices the necessary supply of dry steam, so that it may enter in a divided form and rapidly mix the

N. J. & H. Ry. & F. Y. Co. power house, Edgewater, N. J. Both stacks five minutes after firing.

atmospheric air with the heated gases of the fuel in such proportions as to effect their complete combustion, and this is just what this device does.

In the burning of coke (or when the coal has burned down to a clear and red fire), although combustion on the grate may appear to be perfect, little or no flame be produced and no smoke whatever made, yet there may be a great amount of useful heat lost owing to the formation of carbonic oxide. If this carbonic oxide does not find a fresh supply of sufficiently heated air (oxygen) at the proper place, it necessarily passes off unburned. This is obviated by the Thomas smoke-preventing and fuel-saving device.

By applying practically, on the large scale of the furnace, those chemical truths which are so well known in every laboratory, the inventor of this device has succeeded in accomplishing with an inexpensive and absolutely automatic apparatus perfect combustion in the furnace (making all fuels smokeless and their fumes odorless), utilizing a maximum of the heat units, and increasing the efficiency while lessening the quantity of fuel required by 10 to 18 per cent.

METHOD OF OPERATION.

To accomplish the desired end, superheated steam is introduced through jets at the time of firing, over the furnace doors and into the fireplace above the fuel. The steam acts as a "poker" to stir about and intermix the air (or oxygen) with gases arising from the fuel, and thus completes the intermixture required for effecting complete combustion. The supply of external air is introduced through a damper in the furnace door that is automatically regulated by the device, and passing through a perforated baffle plate is heated before reaching the fire, as will be seen by the accompanying drawing and description.

Recognizing that furnaces are not all alike, that even those of the same make differ some-

N. Y. Tunnel Co. Another attempt to photograph some smoke.

what in their action, it regulates each and every installation so that steam and heated air shall be admitted to the fire only just so long as the fire needs them completely to consume smoke and volatile gases given off when fresh coal is thrown in. This time varies from one to two minutes, according to kind of furnace, boiler and coal used.

SOOT DEPOSITS PREVENTED.

Aside from the direct economy of fuel effected by more complete combustion in the fire box, this device increases the efficien

the boiler by preventing deposits of soot on boiler tubes and in the stack. It is known that a deposit of soot one-eighth inch thick on tubes will decrease boiler efficiency 15 to 20 per cent. Practically no soot is found on tubes where the furnace is equipped with the Thomas device.

NO OBJECTIONABLE FEATURES.

The objection brought against the use of a steam jet up to the present time has been that it dampens the fire box, decreases life of boiler, and does not economize fuel. This is because it has been excessively used and uneconomically applied. Steam alone will not suffice, air alone will not suffice. But steam and heated air together, admitted in the right manner [illegible] for the right time, and to the right points, as accomplished by the Thomas device [illegible] prevent practically all smoke and [illegible] Steam [illegible]

New Compressor Valves.

By Max [illegible]

R[illegible]

dashpot room above the piston, the action of the valve is in such manner that during the discharge period—when the valve remains on its seat—the compressed air finds its way through the hollow spindle into the dashpot.

Assuming the valve to begin the suction stroke the air in the clearance spaces expands while the pressure of the air enclosed in the dashpot cannot decrease so rapidly through the small opening. This means that the prevailing pressure will force the piston downward with a force depending upon the area of the piston thus securing full valve opening. If the valve is arranged vertically the springs may be dispensed with as the motion of the valve takes place in the same perfect manner as numerous tests have proven.

The air contained in the dashpot is forced back into the cylinder when the valve is closing, therefore serves as cushion.

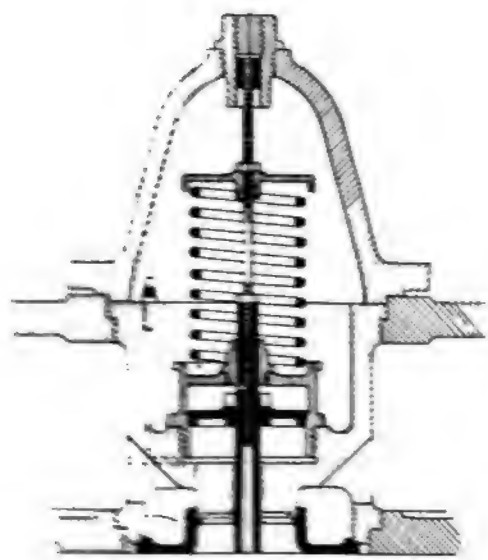


Fig. [illegible]

[illegible] chamber is kept small [illegible] detrimental influence of [illegible]

[illegible] with this type of suction [illegible] severe tests, the [illegible] eff. for a [illegible] 45 and [illegible] 45. The [illegible] stroke is in [illegible] as to be in [illegible] valve from its [illegible] of the dashpot [illegible] of the new

type. The chief feature lies in a little auxiliary valve whose function it is to prevent the air—which during the upward motion of the valve is displaced, to return as soon as the opening, leading to the auxiliary valve is closed by the valve proper, the remaining air begins to act as cushion and prevents the valve from striking against its guide. On the return stroke

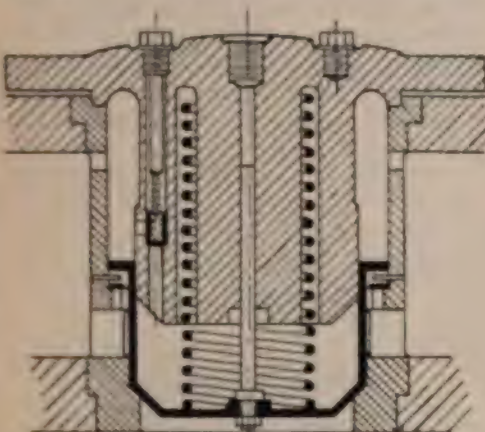


Fig. 2

the air between the valve and its guide expands, decreases in pressure therefore and offers less resistance to the pressure required to open the valve on the next stroke. Another discharge valve is shown in Fig. 3, the peculiarity of this valve lies in the action of the spring.

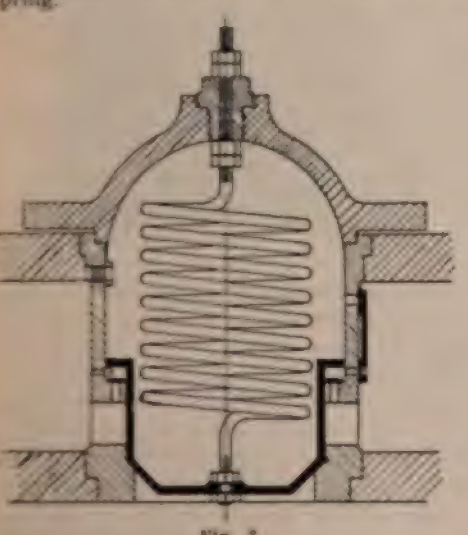


Fig. 3

The spring in the position of the valve above the inlet opening in the valve cage is balanced, i. e. not loaded except for the weight of the valve proper. On the way between this opening down to the position of the valve on its seat the spring is in tension and remains so until the next discharge stroke takes place, when the spring pulls the valve rapidly from

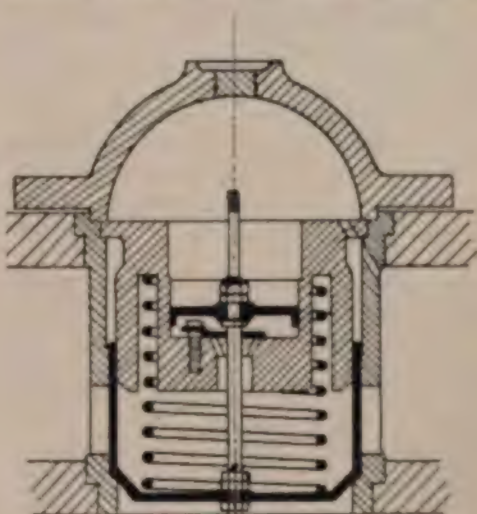


Fig. 4

its seat. The spring is compressed, however, when the valve on its upward motion has overlapped the cage opening, thus storing up energy for the downward closing stroke.

Another discharge valve is shown in Fig. 4. It is fitted with dashpot and piston and a series of little holes, covered by a disc shaped

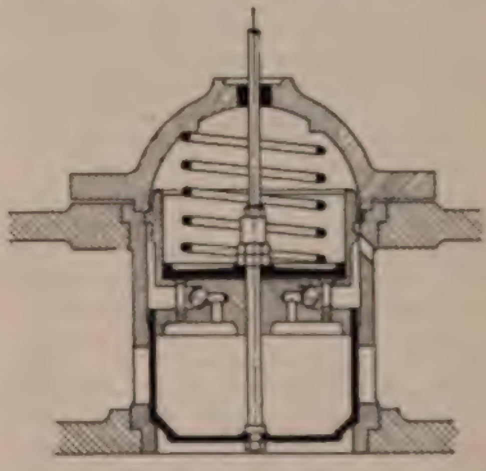


Fig. 5

back pressure plate, connects the room between valve and the guide with the room underneath the dashpot piston. The air v

between the valve and its guide therefore, can escape when the valve proper is opened.

The action of the valve is that shown in Fig. 5 is easily understood from the sketch.

New Incandescent Lamp.

ANOTHER modification of the familiar many. The improvement this time is incandescent lamp is reported from Ger- a new metallic filament which combines the notable features of cheapness to manufacture, comparatively long life, and what is more important, small consumption of energy per candle power. While the details of the filament have not been published, owing to the pending of patents, it is rumored that tungsten is an important element in it, and that the honor of the invention belongs to Dr. Hans Kuzel, of Baden. According to some figures from the official organ of the Vienna Electrical Society a 16-candle power lamp may be operated with an expenditure of the energy of approximately 20 watts, which is less than half the current consumption required with the familiar carbon now in vogue.

A Roller Bearing.

By Louis Villatte, Watertown, N. Y.

IN the accompanying drawings: Figure 1 is a top or plan view; Figure 2 is an end elevation, one-half shown in section.

Referring to the drawing 1 denotes the shaft to which is secured a hardened steel sleeve 2. Said sleeve may be secured to the shaft 1 in any suitable manner, but is preferably fixed to the same by means of the key and lock screws as shown.

On each end of the sleeve 2 are arranged bearing ring 3 through which the shaft 1 is adapted to pass. The rings 3 are provided on their inner sides with annular flanges 4 fitted over the ends of the sleeve 2 forming caps. In the rings 3 a series of bearing apertures 5 and bolt holes 6. Journaled in the bearing apertures 5 are anti-friction rollers 7, *the ends of which are reduced where they enter said apertures so that a shoulder is formed on said roller thereby preventing any longitudinal shifting movement of the same. A valuable advantage over the conical end rollers.*

Through the bolt hole 6 are passed the ends of clamping bolts 8, said ends being reduced, thereby forming shoulders on said bolts which are engaged by the inner edge of the rings 3. A nut is applied to the outer ends of said bolts, thereby clamping the same and said rings firmly in place. The rings and rollers 7 are encaced within a hardened steel box 9, the inner surface of which forms annular bearings for the rollers and in which the same are adapted to turn with the rotation of the shaft 1.

The inner diameter of box 9 near each end is enlarged, as shown at 10, whereby the bearings rings 3 are accommodated. The box 9 is octagonal in shape on its outer side and is

Fig. 1.

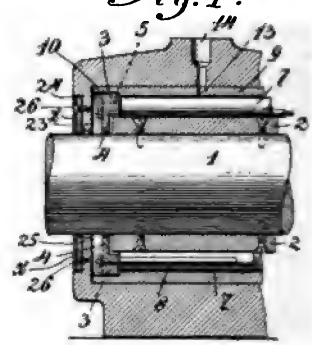
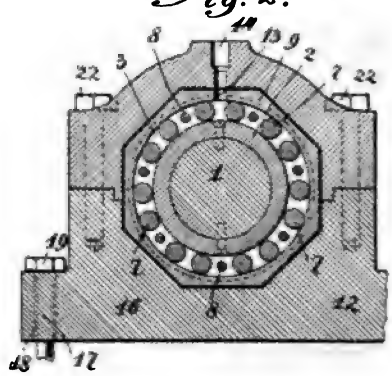


Fig. 2.



adapted to fit within an octagonal shaped opening in a pedestal or support 12 or of any design.

On each end of box 9 a cap 23 secured by means of the screws 26, and caps having a recess 24 to receive a packing ring 25, the inner edge of which is adapted to closely engage the periphery of the shaft 1 thereby preventing the entrance of dirt and also preventing the spattering or splashing out of the lubricating oil from the inner side of the bearing. Said packing ring is secured in place by means of a metal holding ring and screws 26.

In one side of the box 9 is formed an oil hole 13 in line with an oil hole 14 formed in said pedestal.

The pedestal 12 is formed on each end of inwardly projecting annular flanges 23, the upper faces of which are recessed as at 24 to receive a packing ring 25. On the packing rings 25 is arranged a circular holding ring which is adapted to be secured to the flanges 23 by means of the screws 26.

The rollers 7 are lubricated by means of oil passing from the oil cup through the aligned oil holes 13 and 14 into the space within the box 9 into which said rollers are located and which pass to the lower side of said box where it may stand and through which each roller must pass as the same is revolved,—thereby immersing or bathing said rollers in the oil at each and every revolution of the shaft, thus keeping the parts well lubricated and thereby *making of this invention the only reliable self lubricating device ever known.*

In a roller bearing constructed as herein shown and described it will be seen that the friction will be taken up by the roller, thereby preventing or materially decreasing the wear of the parts, as also a great economy of power consumption.

From the foregoing description taken in consideration with the drawing the construction and operation of the invention will be readily understood without requiring a more extended explanation.

High Duty Metal.

IT is a well known fact that the copper alloys known as brass and bronze generally suffer a marked reduction in strength with increase of temperature. This loss of strength is not generally taken into account because the deterioration is slow up to a certain point, and this point is above the temperature of steam or air at the usual pressures. At about the temperature of 150 to 175 pounds steam the loss begins to be very rapid, and at about 400° F there is a sudden marked drop in tenacity. From that point to 500° F. the loss is very rapid and the strength of the material is seriously affected.

In designing their new line of Extra Heavy and Medium Pressure Brass Valves, the Western Tube Company, Kewanee, Ill., determined to use the metal which would show the smallest percentage of loss in this respect that it was possible to obtain, the same metal to have other qualities which are essential in a valve at all times and particularly in a valve for use under high pressure.

In endeavoring to secure this metal, an effort was made through the Secretary of the American Society of Mechanical Engineers to collect all of the existing literature upon the subject, and it was discovered that practically all that has been determined on this question is the results of the experiments of the British Admiralty in 1877 as described on page 309 of Kent's Manual. Having found that no further light was to be obtained from past researches, this company inaugurated an exhaustive series of tests with a large number of mixtures of copper, tin, zinc and other metals, with the purpose of determining for itself absolutely the best metal for its purpose.

These experiments have extended through a period of eight months, and the statements made above have been fully corroborated and emphasized. For instance, it was found that an alloy that is very commonly in use as steam metal and would be called a fairly good metal for this purpose, showed a drop in tensile strength of as much as 28 per cent when raised to the temeprature of 407° F., which is about the temperature of steam under 250 pounds pressure without superheating. It was assumed that this temperature would be a fair one at which to make these tests, inasmuch as engineering practice is tending strongly in these days to the use of steam at about this pressure, or superheated from a lower pressure to this temperature.

Another metal which has been considered an excellent mixture and is frequently used by valve makers for valves of higher grade and designed for higher pressure, showed 22 per cent loss under the same conditions.

The well known "government" mixture, as it has been called, consisting of 88 parts of copper, 10 of tin and 2 of zinc, was found to be as little affected by this extraordinary increase of temperature as any alloy which has ever been used, as far as known, in the manufacture of valves. The "government" mixture was found to have as an average of a large number of bars tested, a cold tensile strength of 33,633 pounds per square inch. When raised to 407° F. and again tested, the temperature being maintained constant dur- the test, the tensile strength dropped to

pounds per square inch, showing a loss of nearly 9 per cent.

They say that after making all of their experiment, they have arrived at an alloy which is practically of the same tensile strength as the above mixture when cold, as it shows an ultimate strength of 33,520 pounds per square inch at 70° F., and further, it shows an ultimate strength of 31,627 pounds per square inch at 407° F., the loss being *only 5.6 per cent.*

A table is appended which shows in summarized form the results of these experiments upon six different alloys, as follows:

Alloy	Tensile Strength at 70° F.	Tensile Strength at 407° F.	Loss Per Cent.
No. 1..........	21,790	15,640	28.2
No. 2..........	29,010	22,410	22.4
No. 3..........	24,510	22,059	9.5
No. 4..........	33,633	30,675	8.8
No. 5..........	33,710	31,305	7.1
No. 6..........	33.520	31,627	5.6

No. 1 is the steam metal alluded to above and which is in common use among valve manufacturers.

No. 2 is a metal which this company use at times and is fairly strong and durable at comparatively low temperatures.

No. 3 represents one of their earlier experiments illustrating the advance along the line of research, but indicates too low tensile strength.

No. 4 is the "government" mixture, so called.

No. 5 is one of their later attempts, and No. 6 is the mixture which has finally been adopted and is called by them "High Duty" Metal.

In addition to the rare quality of maintaining the high tensile strength at high temperatures, this metal also shows wearing qualities which are very remarkable; and as wearing qualities in the moving parts of a valve are of the utmost importance, the "government" mixture was again taken as the unit or standard, and it was found, by means of a special machine in which the movements of the parts of a valve were imitated exactly under extreme conditions of friction and at high temperature, that this metal wore away at about one-third the rate shown by the "government" mixture mentioned above.

This alloy has also been found to be very tough, resisting shock or water hammer with greater success, and is, in fact, far less brittle than any other of the metals tested.

In strength under compression it again showed marked superiority, as the flow of the metal was extremely uniform under high pressures, much more so than any other alloy upon which these tests were made.

Further, and this is very important, this metal makes sound, tight castings. These tests prove this conclusively, and this quality works to the benefit of the user equally with the company.

In every respect, then, this "High Duty" Metal may be said to be the metal par excellence for the manufacture of valves and cocks for extreme temperatures and pressures, and we believe it to be well named.

They are taking this means of announcing that their entire lines of Medium Pressure Brass Valves, designed for pressures ranging between 125 and 175 pounds, and our new line of Extra Heavy Brass Valves, designed for pressures up to 250 pounds, are now and will hereafter be made of this "High Duty" Metal.

They are also prepared to furnish any of their goods now made of excellent standard brass mixture, made up in this "High Duty" Metal, thus giving their customers the advantage of valves having over 40 per cent greater strength and efficiency in the lighter weights at an advance in cost of about 25 per cent.

In general, they believe that they have discovered a metal whose name is expressive of its substantial merit, and that its use marks a long step in advance in valve construction.

Foreign Industrial News.

Iceland will have a system of land telegraphy this fall.

A market for bicycles at Nankin, China, is said to be created by the extension of macadamized carriage roads around that city, bringing the total length up to 40 miles.

Galvanized sheets from Germany are supplanting the British product in Roumania, states a London report. Textiles, agricultural machinery, tin plates, and roofing sheets are in strong demand in Roumania.

A steel passenger car has recently been completed in Pittsburg for the Southern Railway which is regarded as the beginning of the general use of steel instead of wood for all kinds of railway cars. The car is 74 feet 6 inches long over all, and weighs 110,000

pounds. There was no wood used in its construction except for the interior decorations, and that wood was made fireproof. It is said that the car could not be telescoped in a collision, neither could the ends be smashed in, and furthermore, it is noncombustible. Two other cars of similar nature are under construction. If generally used, such cars would greatly reduce the dangers of railway travel.

The remittances to China made by coolies or laborers at work in other countries is now estimated to reach $50,000,000 annually, including $5,000,000 said to be sent home by the indentured coolies in the Transvaal mines. This is one way China meets her adverse balance of trade.

The Central South African Railway's administration is considering the question of establishing a steel plant to deal with scrap. Of this the administration owns a large quantity, but can find no local use or market for it. A similar plant, owned by a company, is in course of erection at Zuurfontein, Transvaal.

In 1896 tin was quoted in the English market at $270 per ton. It is now quoted in the same market at about $970 per ton. Sudden fluctuations have carried it as high as $1,042. Market manipulations cause part of this rise, but the increased demand for the metal has caused at least one-half of the general increase.

The engineering work contemplated or discussed in Manchuria and Mongolia includes railroad maintenance and improvement, and increased railroad mileage, both by the Chinese and Japanese, and, possibly, in northern Manchuria, by the Russians; wharf-building operations at the port of Newchwang, and road building by both Japanese and Chinese.

Creosote oil is a developing article of export from Sunderland, England, to the United States, writes Consul Metcalf, of Newcastle. Creosote is being more extensively used in America for the preservation of lumber, and the creosote oil is produced very cheaply in England from the coal tar refuse of the gas works.

The largest marine gasoline engine in the world is about to be shipped from Baltimore to Russia. It is of 1,600 horsepower, and is one of four ordered by the Czar's Government at a cost of $100,000 from White & Middleton to go into Lake submarine torpedo boats. The firm is expecting similar orders from the German Government.

The amount of lumber sent from Nova Scotia to American ports this year is very large, reports Consul-General Holloway, of Halifax. The cut in Annapolis and Cornwallis exceeds any cut known there for many years. The lumber shipped from Cornwallis is largely supplied by the New York Lumber Company, which owns 45,000 acres at Gasperaux Lake.

With the object of further improving and developing industries, the department of agriculture and commerce of Japan is to dispatch agents to Europe and America to make purchases of up-to-date machinery. For example, dyeing and weaving machinery will be purchased, to be rented to those so circumstanced as to be able to use it to advantage under regulations.

In the Department of the Landes hundreds of portable steam engines are employed in the pine forests for sawing, and the present high price of turpentine and pine wood makes this department an exceptionally rich field. Large semiportable engines of from 80 to 300 horsepower for producing electric currents are now finding their way into Bordeaux from Germany.

An attempt is about to be made by an Austro-Hungarian firm to utilize the reeds and rushes of the Danube delta in the manufacture of sacks. It is said that very successful experiments have been made with a view of producing cloth suitable for sacks from these products, and that the firm in question have arranged to spend $200,000 in the construction of a factory either at Galatz or in the delta for the manufacture of this article. Similar experiments have been made in the past but without satisfactory results.

A great building boom is now in progress in Rio de Janeiro and is likely to be followed by similiar movements in a number of Brazilian cities. The style of building in Brazil involves the us eof considerable cement, and the very large amount of street paving now in progress in Rio de Janeiro is constructed upon a foundation of unusual depth, composed of concrete in which there are three parts of sand, six parts of crushed stone, and one of

first class cement The Brazilian engineers are running to cement construction in many lines roads, bridges, water tanks, tunnels, steps up the steep hills of Brazilian cities—in fact, the uses of cement are very general.

The increasing interest in what is termed welfare work of industrial establishments is shown in the work being done in Kinkora, on the Delaware River, 10 miles below Trenton, N. J., where John Roebling's Sons are expending [illegible] in providing model homes [illegible]

[illegible]

[illegible]

cause it costs too much to maintain this department. The models are to be distributed among educational institutions. Mr. R. C. Gill has been keeper of the models for 40 years.

Wreckers Well Paid.

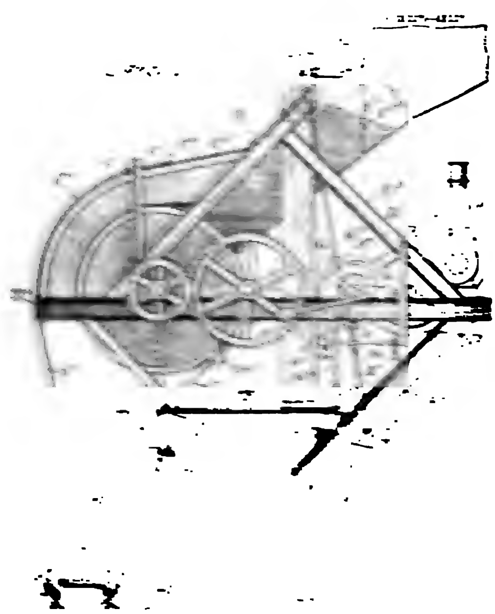
New York—Wreckers have recovered nearly [illegible] of cargo from the hold of the freighter Drumelzier, which went ashore Christmas week, 1904, and sank. The prize of all the cargo is a $20,000 automobile.

New Inventions.

The following inventions have been specially reported for Browning's Magazine by C. Le-Roy Parker, Solicitor of Patents, 639 F. St., N. W., Washington, D. C.

[illegible] APPARATUS

IN [illegible] material such as coal upon cars [illegible] necessary to stop each [illegible] relatively to the [illegible] sta-



[illegible]

ented by William J. Selleck, of Riverside, Conn., is to provide a loading apparatus by means of which moving cars may be successively filled with material automatically as they pass a given point without requiring them to stop.

The apparatus is so arranged that an approaching car trips a lever which discharges a load of coal into this car and returns it to a position to be filled whereupon an oncoming car will repeat the operation.

MEANS FOR DISTRIBUTING MINE RESIDUES.

THIS invention, recently patented by August Ludwig Emil Bergert, of Johannesburg, Transvaal, has especial reference to apparatus intended for distributing mine residues—that is to say, to apparatus intended for conveying to and dumping or depositing such residues upon a mine dump or depositing site.

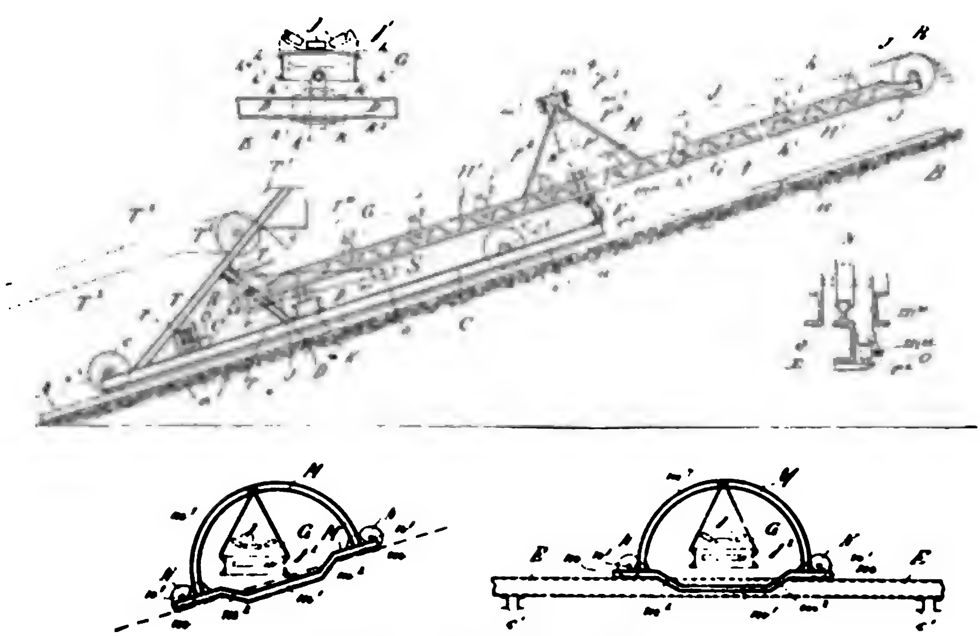
The apparatus comprises a wheeled frame or carriage which is adapted to traverse a track or rails laid on the dump or depositing site, upon the top of which frame or carriage is mounted a structure which pivotally supports a boom or jib carrying an endless conveyor belt or band, onto the receiving end of which is fed the material to be conveyed and distributed.

The structure which is mounted on the carriage is constructed to provide a curved track radial to the pivot or point about which the boom swings, upon which radial track a vehicle which supports the boom at or in proximity to the center of its length is free to travel as the boom is swung to either side of the main track or the rails upon which the wheeled carriage runs.

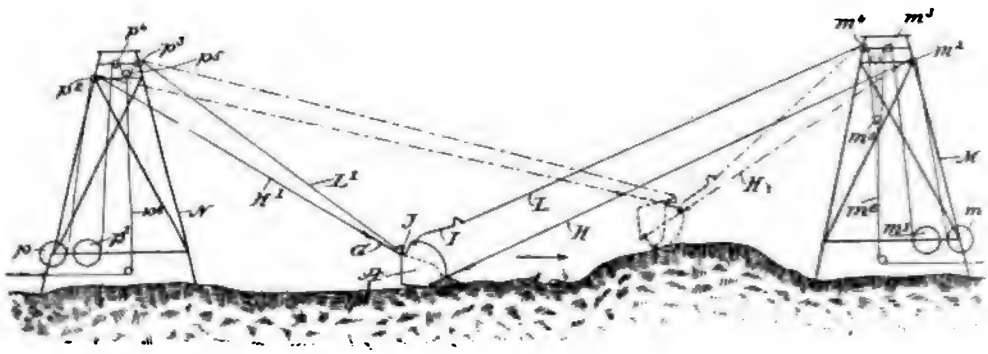
The boom carrying the conveyor-belt at its rear extremity in such a way that it can swing in the plane of the carriage to either side of the main track and so that it may oscillate about its longitudinal axis to prevent the belt beng inclined transversely when the boom is swung to either side of the main track.

EXCAVATING APPARATUS.

IN this apparatus the inventor, R. B. Page, of Los Angeles, California, employs a reversible scraper having two cutting edges adapted to be hauled in an operative condition on each trip back and forth across a ditch, canal, or other ground it is desired to remove. With the scraper is associated means for holding it in the required condition during the excavating and loading operation and when fully loaded, said means being also effective in dumping the scraper when it reaches the point of discharge.

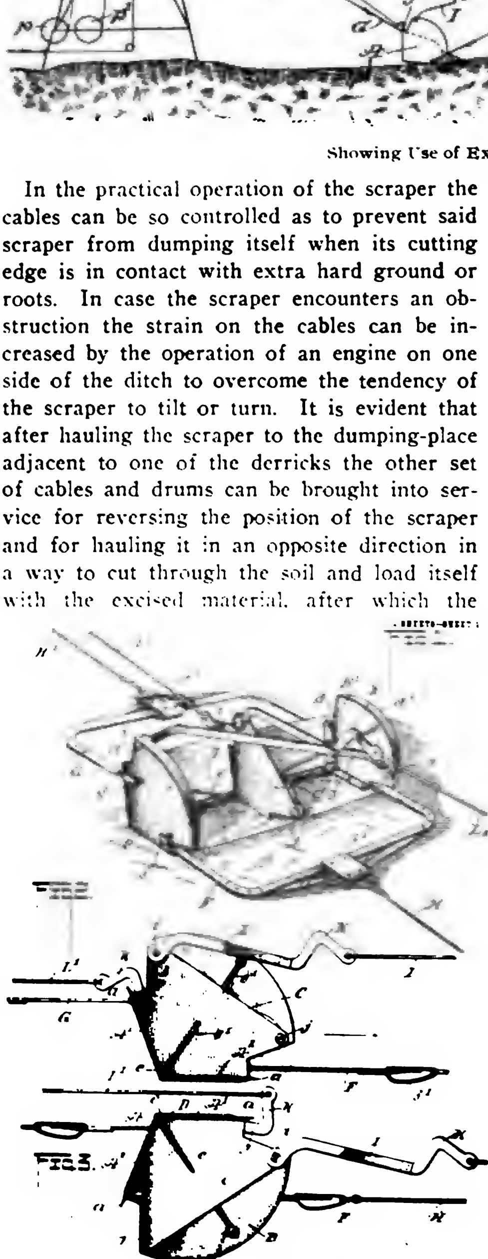


Machine for Distributing Mine Residues



Showing Use of Excavating Apparatus.

In the practical operation of the scraper the cables can be so controlled as to prevent said scraper from dumping itself when its cutting edge is in contact with extra hard ground or roots. In case the scraper encounters an obstruction the strain on the cables can be increased by the operation of an engine on one side of the ditch to overcome the tendency of the scraper to tilt or turn. It is evident that after hauling the scraper to the dumping-place adjacent to one of the derricks the other set of cables and drums can be brought into service for reversing the position of the scraper and for hauling it in an opposite direction in a way to cut through the soil and load itself with the excised material, after which the



Scraper for Excavating Apparatus

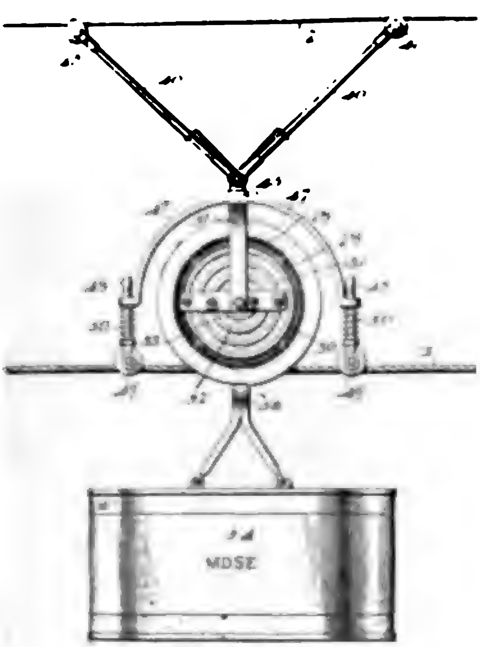
scraper in the reversed position may be dumped in the manner described, and said scraper can thereafter be reversed, so as to operate when moving in the first-named direction. (Indicated by the arrow.)

AERIAL ELECTRIC TRANSPORTATION SYSTEM.

THE object of this invention, recently patented by George C. Schroeder, of Washington, D. C., is to provide a system having a car or carrier which is adapted to travel upon a suspended cable or track. Said car or carrier is fitted with an electric motor which constitutes a prime mover and furnishes the motive power. Suspended, preferably, above and extending parallel with each other are four current-wires, two of them adapted to act for transmitting the current to the motor and two of them adapted to act as return wires. The motor is provided with four trolley arms, each of which is adapted to come in contact with one of the said current-wires, and each of the said trolley-arms is electrically connected with the said motor.

The prime object of the system is to so arrange the apparatus that the car may be sent back and forth upon the cable, stopped at any desired point, and made to travel at any desired rate of speed. The movement of the car in either direction is controlled by the manipulation of switches and a pole-changer located at either terminal station or a way station. Each car or motor is provided with a means to prevent rocking thereof in the line of travel and also to guide the car around the curves. Said means also prevents any tendency of the motor to climb or jump the track. The trolley-arms are also arranged so as to prevent lateral rocking of the car. Said trolley-arms are mounted upon a base which is pivoted to the top of the frame of the motor, so that the

Fig 3.

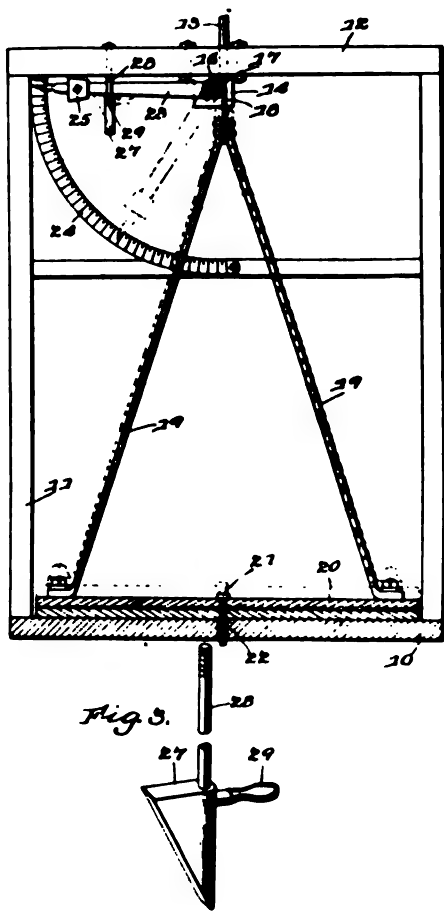


said trolley arms may follow the wires while the motor is rounding a curve in the track.

WEIGHING APPLIANCES FOR ELEVATORS.

IN this invention, which forms the subject matter of a patent recently issued to Anton Aker, of Helena, Montana, there is secured to one end of a cross shaft 16 an indicating arm or pointer 23, the outer end of which is adapted to travel over a graduated arc 24 that is secured to the frame of the elevator, and mounted on this indicating arm 23 is a weight or poise 25, which may be adjusted toward and from the shaft 16 for the purpose of counterbalancing the weight of the scale platform and the members between the platform and the shaft. If left free, the indicating arm 23 would descend over the arc and indicate thereon the weight of any load placed on the platform, and in order to prevent this movement during the reception of the load the indicating arm is held elevated and the platform is lowered into contact with the bottom of the elevator by a latch 27, that is carried by a pin 28, and is provided with a suitable operating handle 29, by which it may be turned to present the face of the latch under the indicating arm or moved from under the arm in order to allow the latter to descend.

Prior to the reception of the load the attendant raises the indicating arm to the highest point and turns the latch to the full-line position, so that the platform 20 will be lowered into contact with the bottom of the elevator. The load may then be placed on the platform without jar or shock, and after the reception of the load the attendant turns the latch 27 and frees the indicating arm, the latter lowering to a position necessary to counter-



balance the load and indicate its weight on the arc 24. After the load is raised the arm is again raised to inoperative position and the load-receiving platform lowered against the bottom of the elevator. The indicating arm is then locked in place, and the elevator is operated in the usual manner to raise or lower the load.

A New Noiseless Gear.

A patent on a noiseless gear, the invention of F. E. Bocorelski, superintendent of the Baush Machine Tool Company, Springfield, Mass, has been applied for. It consists of a cast iron blank, with a sleeve upon which are fitted three rings, each of a different material —bronze, fiber, and steel. These sections are held in place by a key and by three riveted pins, thus forming of the four materials a practically solid gear blank.

An exhaustive test of one of these gears has been made in a 42 inch Baush boring mill in mesh with a cast iron gear. The desired noiseless quality, commonly acomplished by rawhide and similar gears, was demonstrated, and also the wearing quality, which was the inventor's chief purpose.

The gear wore no faster than its quickest wearing member. It does not get out of shape, and wears longer than a solid steel gear. There is also, as the test proved, ample strength in the new gear.—*The Iron Age*, Sept. 27, 1906.

An Increasing Use of Scrap.

The increase in scrap used in 1904 over the total for 1900 is 24.0 per cent. In the same period pig iron production increased 19.6 per cent. The consumption of scrap in the four years, therefor, increased about one and one-fourth times as rapidly as the consumption of pig iron. This is particularly important because the year 1904 was not as good a year for scrap outcome as was 1900.

It is well understood that the future must place more and more dependence upon scrap as raw material. The increasing use of scrap and the making of better steel, by alloying and otherwise, so that where one ton is now required for a given purpose the future will require less than one ton, must be depended upon to mitigate the effects. Not of the iron ore famine which has been predicted in some quarters, but of the steadily increasing market value of iron ore.

It cannot be said yet that the scrap used is made into better steel than it was, but it is not improbable that within the lifetime of the present generation scrap will be made into steel of which a given number of tons will perform a much greater service than the same number of tons of the quality which that scrap possessed in its day.—*The Iron Age*, Sept. 27, 1906.

Horsepower of the Victoria Falls.

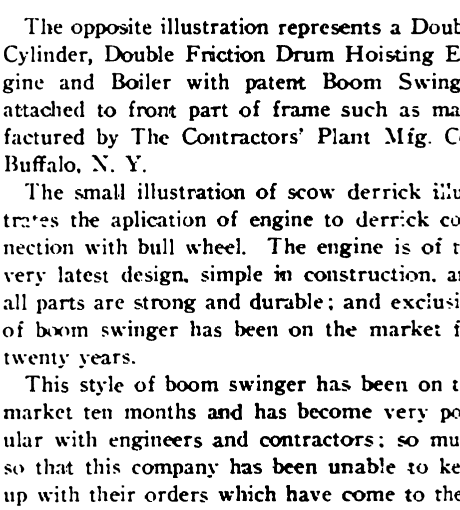
It is estimated that if the Victoria Falls, situated on the Zambezi river, in the territory of the British South Africa Company, could be utilized to generate electricity by means of turbines, the power developed would be equal to 200,000 H. P.

Derrick Boom Swinging Engine.

The opposite illustration represents a Double Cylinder, Double Friction Drum Hoisting Engine and Boiler with patent Boom Swinger attached to front part of frame such as manfactured by The Contractors' Plant Mfg. Co., Buffalo, N. Y.

The small illustration of scow derrick illustrates the aplication of engine to derrick connection with bull wheel. The engine is of the very latest design, simple in construction, and all parts are strong and durable; and exclusive of boom swinger has been on the market for twenty years.

This style of boom swinger has been on the market ten months and has become very popular with engineers and contractors; so much so that this company has been unable to keep up with their orders which have come to them since the swinger was placed on the market, and they are now working in all parts of this country.



The boom swinger drums are of the V friction type and revolve on one shaft with friction disc separating drums, which has hardwood friction block on each side to engage drums. The operating is done by one lever in notched quadrant and the drums work simultaneously, one paying off as the other winds on rope. This is accomplished by means of steel pin gear which engages in teeth at friction head of drums. The steel pin gear revolves on pin which is held rigid by heavy ribbed bracket in front of drums. The drums are engaged with frictions by helix set placed

inside of brackets and are connected together so as to allow drums to work simultaneously, one drum to engage frictions while the other disengages. While the boom of derrick is not swinging the drums are forced off frictions by spiral springs on drum shaft, and both drums are braked by pin gear, which does away with extra brakes on engine as formerly used. By placing the operating lever on center the hoisting drums are operated without swinging boom.

The speed of boom swinger drums are reduced so as to enable the operator to hoist load at full speed and swing boom at the same time. The drum disengaged cannot pay off more rope than is wound on engaged drum, which avoids the use of tighteners or brakes.

It has been thoroughly demonstrated that this swinger is the most practical machine manufactured for the swinging of boom derricks up to 20 ton capacity on account of its durability, simplicity in construction and manipulation.

There are more than one advantage in using a power swinger as one can readily see by observation. It does away with two, three, and sometimes more, laborers to work tag lines, which cost considerable and the contractor is unable at times to get these men. It also concentrates the operation of derrick and engine in the engineers, and makes very little extra work for him, and in the course of three months the contractor has saved enough by this method to pay for boom swinger and bull wheel, and thereafter the cost of swinging is little or nothing.

The Contractors' Plant Mfg. Co. have been allowed a patent on this boom swinger which is ample evidence of its merits and they solicit the correspondence of any one who might be interested.

Comparative Efficiency of Pop Safety Valves.

(A Thesis presented by A. F. Bardsley and K. E. Miller for the degree of B. S. in Mechanical Engineering at Case School of Applied Science, 1906.

In conducting this series of experiments our object was to determine the relative efficiencies of several of the standard makes of safety valves, that is, the amount of pressure reduction and the time to accomplish this reduction under given conditions of evaporation and with equal pressures.

A gage was secured from the Bristol Recording Gauge Co., of the following construction. The pressure is transmatted to a pen through a diaphragm and lever mounted on a heavy spring to protect the pen from sudden vibrations. This pen moves across the cards in an arc of a circle. Meanwhile the card is turned by clockwork so as to revolve once in an hour. To aid in locating on the curve, traced by the pen, the cards are ruled with concentric circles denoting the pressure and arcs, parallel to the arcs of the pen's motion, to denote time.

This gage we mounted firmly on a plank fixed to the boiler setting to protect it from any vibration in the building. A quarter inch pipe was then run from the boiler to the gage with a syphon pipe attached, to keep water between the steam and gage, thus protecting the diaphragm from danger of overheating. A water meter was connected in to the feed water circuit and a thermometer placed in a cup in the same circuit and we were ready for a test.

The tests in themselves were simple. With the whole load on the one boiler, the Heine, we forced the fire, running the pressure up to the popping point. As soon as the valve popped the air doors were closed, as in actual service, and the time noted. On a log provided we then noted the pressure of popping and the time by watch, to enable us to locate the particular pop on the chart. Then after the valve closed, we noted the number of seconds it had remained open and the pressure at which it closed. Meanwhile, the water meter and thermometer readings were taken every ten minutes.

The valves tested were secured through the kindness of the Crosby Steam Gauge and Valve Co., the Consolidated Safety Valve Co., and the Ashton Safety Valve Co. The companies describe their valves in their respective catalogs as follows:

The Crosby is of the Inspective type. The seats are of gun metal, bronze or nickel, to prevent corrosion. The valve lifts vertically from the seat. A bonnet is provided to protect the valve and for use during inspection.

The Consolidated valves are also furnished with solid nickel seats to prevent corrosion or sticking. The seat makes an angle of forty-five degrees with the axis of the valve. The spring is nickel plated to prevent corrosion and bears, top and bottom, in ball and socket joints to prevent buckling, or cramping, which would bind and prevent lifting at the proper pressure. A patent screen ring is provided so that the popping point can be changed while the boiler is under pressure. The working parts are of a special metal.

The Ashton valves are also of highest grade metal with nickel seats beveled to forty-five degrees. They have, however, a pop chamber with a knife edged lip which wears evenly with the seat. The spring is encased in a chamber to protect it from the steam and to serve as a guide for the upper part of the valve. The springs are made of Jessop's steel and are pivoted top and bottom on discs to insure a true bearing. A screw plug of special construction is provided to regulate the pressure at which the valve closes and a compound adjustable cam lever facilitates the changing of the popping point.

From noting the action of the valves, we have arrived at the following conclusions. The consolidated valve opens and closes suddenly, as the makers claim, giving a quick drop of pressure below the danger point at the start. However, this sudden wide opening produces a jar and a roar that shake the whole surroundings. The Ashton and Crosby valves on the other hand open and close more

gradually and with much less vibration and shock, the Crosby, in fact, being almost noiseless.

The following summary of data from the 3" valves will show these relations more clearly:

Valve	Popped at	Closed at	Reduction.	Time in secs.	Water in 10 mins.
Ashton A	149.27	143.59	5.68	66.31	686 lbs
" B	142.481	137.296	5.186	66.4	865 "
Consol	147.758	141.175	6.568	42.167	586 "
Crosby	146.413	141.217	5.196	55.63	684 "

It is seen that the Consolidated valve is open the shortest time and gives the largest reduction in pressure although working under a slightly lower water consumption. The Ashton and Crosby valves gave a less reduction and took a greater time to do so.

The following table shows the average data for the 3½" valves:

Valve	Popped at	Closed at	Reduction.	Time in secs.	Water in 10 mins.
Ashton	143.886	139.43	4.456	57.05	718 lbs
Consol	146.085	140.405	5.69	38.69	558 "
Crosby	148.5	143.522	4.978	40.681	481 "

From this table we see that the conditions are relatively similar to the 3" valves. It also shows a shorter time for the same reduction of pressure with the 3½" valve than with the 3" valve. This is only natural, for the 3½" valve has a greater area of opening than the 3" valve.

Packing Engines.

The problem of packing an engine is discussed in *Gas Power*, by Messrs. Knowles & Rowland, Deming, N. M.

"The cause: If a gasket be cut from sheet asbestos and screwed down dry or with insufficient oil or white lead, it is too hard or unyielding to compress properly. Then when the water soaks through, even if in only one little spot, it reduces the asbestos to a pulp and it blows out.

"Hence, the remedy: First, cut a gasket to properly fit the cylinder; any thickness of sheet asbestos will do from 3-16 to 1-32 inch, but ¼ inch is about the best thickness. Fit it very nicely so that it will come off and go back on again easily.

"Second, place the gasket in a basin or pan of—water! Then put it back on again. If you want to do a good job graphite the outer side so that it will release from the cylinder head, if you ever want to take it off again without destroying the gasket, and screw the cylinder head down tight.

"Now you have a pulpy mass between the cylinder and head that is compressed into a hard and unyielding substance and you have filled up every inequality of the surfaces. You can turn the water in the jacket as soon as you have finished and start the engine. Your gasket will hold forever, unless you allow the studs or bolts to become loose. We learned the above process from a fellow engineer, Mr. Conelly, several years ago and we do not know what blowing out one of our gaskets means."

Saving of Driving Belts.

In *Zeitschrift fuer Berg und Huettenwesen* it is asserted that driving belts can be saved, so far as their tension is concerned, by taking them off while the machines are idle. Tests with equal material and exactly the same amount of work have demonstrated that belts which were thrown off every evening had to be tightened only once, while belts which were left on the pulleys while idle had to be tightened five times. Moreover, the belts which were left upon the pulleys were worn out much quicker than the others.

Running Boring Machine by Auto.

Power is power, whether it is generated in a stationary steam engine or the gasoline motor of an automobile. If there is enough of it, the power in the automobile engine will do the work of the steam engine, if it can be suitably harnessed, as shown in *Automobile*. The cylinders of an ice-making machine in Neosho, Mo., had to be bored at a time when the steam engine was temporarily out of commission, so A. P. Sitton just backed his Oldsmobile runabout into the shop, rigged a countershaft under the car with a wood split pulley on it, ran a belt from the flywheel of the motor to the pulley and connected up with the boring bar by sprockets and chains. The motor was started before the tool commenced its cut and was kept going until through the cylinder, and the job was done just as well as if the regular motive power had been used.

Examining an Old Boiler.

BY J. E. H.

As no license is required in many parts of the South, there are many engineers who could not purchase nor advise their employ-

ers correctly how to purchase a second-hand boiler without taking someone's else's word for it. Suppose you were called upon to go to a dealer in second-hand engines and boilers to examine an old boiler with a view to installing it in your plant. For illustration we will take a horizontal return tubular type, 60 inches by 16 feet long, with triple riveted lap seams, and containing 54 tubes and braced with 16 crowfoot braces 1 inch in diameter.

You would first examine it very carefully externally for indications of corrosions and other conditions of plates, rivets, tube sheets, etc. If the external examination is satisfactory, examine it internally for evidences of grooving and pitting, taking careful note of the condition of the tubes and stays. If possible, a hydrostatic test should be made before it is moved. Then the safe working pressure and horsepower should be calculated and also the size and number of stays, to see if they are of the right strength.

Taking the plate at 60,000 pounds tensile strength, triple riveted lap seam, 13/16 rivets, pitch 3¼ inches, having a shearing strength of 38,000 pounds per square inch we will figure the percentage of strength at seam compared to that of the solid plate.

The resistance of the solid strip to a tensile stress is equal to

$$60{,}000\times3\tfrac{1}{4}\times\tfrac{3}{8}=73{,}125 \text{ pounds.}$$

The resistance of the net section to a tensile stress is ¼

$$3\tfrac{1}{4}-13/16\times60{,}000\times\tfrac{3}{8}=54{,}843.7$$

pounds, and as there are three rivets in a single shear to resist shearing stress, the shearing resistance is

$$(13/16)^2\times0.7854\times3\times38{,}000=59{,}107.5$$

pounds.

The calculation shows that the net section is weakest. The efficiency is

$$54{,}843.7\div73{,}125\times100=75 \text{ per cent.}$$

The safe working pressure, using 5 as a factor of safety, is

$$\frac{\tfrac{3}{8}\times60{,}000\times.75}{30\times5}=112.3 \text{ pounds by the gage.}$$

Suppose the tube sheet to be strong enough to brace the sheet to a distance of 3 inches from the outside shell, allowing a margin of 2 inches above the top row of tubes. The area of the segment is

$$\frac{4h^2}{3}\sqrt{\frac{D}{H}-0.608}$$

Substituting values for the letters we have

$$\frac{4\times16^2}{3}\sqrt{\frac{54}{16}-0.608}=567.63 \text{ square inches.}$$

Since there are 568 square inches to be braced and the steam pressure is 112 pounds per square inch, the total pressure on the segment is 112×568=63,616 pounds.

There were 16 braces in the boiler 1 inch in diameter and the total pressure on the segment is 63,616 pounds, then the strain on one brace would be 63,616÷16=3,976 pounds. Allowing 6,000 pounds per square inch of section, the strength of each brace would be 6,000×1×.7854=4,712 pounds.

From the foregoing calculation the boiler is properly braced. The horsepower, allowing 15 square feet of heating surface per horsepower, is as follows:

Heating surface in shell=167.5513
Heating surface in heads= 32.0436
Heating surface in tubes=791.6832

Total surface in square feet=991.2781

991.2791÷15=66.085 horsepower.—*Southern Engineer.*

Receipts.

For a good belt dressing melt together a pound of beeswax and a gallon of neatsfoot oil by gentle heat, stirring slowly, but taking care never to overheat the mixture.

Below are given the ingredients of iron and stone cements which have had extensive use and found to be the best formulas for such articles: Stone cement: Zinc or magnesium oxide, 2 parts; zinc or magnesium chloride, 1 part; powdered stone as dilutent; water to make paste. Iron cement: Iron filings, 40 parts; manganese dioxide, 10 parts; sal ammoniac, 1 part; Portland cement, 20 to 40 parts; water to form a paste.

ENGINEERING REVIEW.

The Policy of Holding Back Improvements.

MANY machine tool manufacturers are holding back some new machine or improvement on an existing machine because of the rush of demand for existing types. Looking ahead—probably a long way ahead—to the time when the demand shall slacken, it is apparent that announcements of new machinery attachments, tools and methods will come from all sides. Every one will be bringing forward something to attract whatever business remains. It will be a grand exhibition of the results of American mechanical brains and enterprise. But will not the great number of new announcements so neutralize one another that few will get any really great benefit?

Machine tool men are influenced in their present reluctance to give to the trade their latest ideas in machine design by two motives —first, the desire to hold something back for the time when they will again have to seek for trade in keen competition with their fellows, and, second, by the lack of time at present to devote to this side of their business. The consideration is also operative that present business might be made even more troublesome and complicated were customers permitted to substitute a new machine or an improvement for that already ordered. But probably, on the whole, many new machines might as well be given to the trade today as at the time in the future when the rule of prompt deliveries shall again prevail.

The modern tendency on the part of those engaged in any line of manufacture of keeping systematic track of all improvements in machinery and methods precludes much of the possibility of a customer forgetting an announncement of this sort. The bringing out of a new tool at this time, when few improvements are being put before the public, must surely attract more attention, with the demand for new machinery probably stronger than it ever was, than an announcement later on, when business falls off and when every builder of machinery is putting forward his improved machines as an inducement for more business. Users of machine tools are now working at high tension. Impressions received are strongly fixed in their memories. Each new machine is considered with the all absorbing purpose in mind of increasing production. Foreign business should also not be forgotten, and improvements should follow along without cessation in order to influence buyers abroad. Altogether there is much to say in favor of bringing before the trade the machines which are now hidden in drafting rooms, instead of waiting to use them as a means of getting business when there will not be enough of it to go around.—*Iron Age.*

The Rack Rail Haulage System in Coal Mines.

THE advantage of mechanical haulage over animal haulage for coal mines is now thoroughly established. Rack rail haulage is a new system, which has recently been described in the *Iron and Coal Trades Review.*

The use of animals on the main haulways is almost obsolete except in very small mines, and in all new operations of any magnitude, mechanical haulage in the main entries is generally employed. The use of animals for gathering coal from the working face to the main parting is still prevalent, but the electric locomotive is gradually invading this field, and we may confidently predict that in the early future the mines of progressive operators will be worked without animal haulage in any portion.

Of the various types of mechanical haulage that have come into use in coal mines the electric locomotive has seen the greatest development. Traction locomotives are, however, limited by grades and work best on flat hauls. They immediately meet with disadvantages when the haulage departs from the level, and the disadvantage rapidly increases with the increasing pitch, the machine becoming

thoroughly impracticable when the gradient exceeds a few degrees. The reason for this is inherent, because the sole reliance for pulling effect is the adhesion of the driving wheels to the track due to the weight of the locomotive. The draw-bar pull of a locomotive equipped with ordinary chilled cast-iron wheels and on a level track, is about 20 per cent of its weight. When it is on a 1 per cent grade, 1 per cent of its weight must be deducted from its draw-bar pull, which is, therefore, reduced one-twentieth, or 5 per cent. On a 5 per cent grade the draw-bar pull is 25 per cent less than on the level, while on a 10 per cent grade it is 50 per cent less than on the level. These figures apply to a locomotive all the wheels of which are driven by a single motor. If each axle of the locomotive is driven by a separate motor, its draw-bar pull is still further reduced by reason of the fact that less than one-half of the weight of the locomotive is on the upper wheels which, therefore, tend to skid and become ineffective, leaving but one motor to do the work. The horse-power capacity of the locomotive is therefore reduced to the horse-power of one motor. This will reduce the draw-bar pull 50 per cent, and from the remaining 50 per cent it is necessary to deduct 5 per cent of the initial draw-bar pull for each per cent of grade. On a 5 per cent grade this leaves but 25 per cent of the initial draw-bar pull for effective work, and on a 10 per cent grade it leaves nothing; it is a well-known fact that a traction locomotive can get itself up a 10 per cent grade, but can not pull up it any considerable effective load. The effectiveness of such a machine on a grade is, of course, somewhat increased by the use of sand, but while sand is effective for starting, or for a short grade, it can not be depended upon for a long up-hill pull. The excess weight on the lower wheels will, moreover, jeopardize the motor driving these wheels by overloading it, because the motor is designed with sufficient capacity to slip the wheels when they carry one-half of the weight of the locomotive. The increased weight results in more power being required to slip them, and if the motor is not capable of carrying the over-load so created, it burns out.

To illustrate this concretely, consider the case of a 10-ton two-motor locomotive on a 5 per cent grade. Its normal draw-bar pull *on a level track* is 4,000 pounds; 25 per cent or 1,000 pounds, must be deducted as representing the effort required to lift the locomotive on the grade of 5 per cent. If now the upper wheels start to slip because they carry less than one-half of the weight of the locomotive, the draw-bar pull is reduced 50 per cent, or 2,000 pounds, from which 1,000 pounds must be deducted as above set forth, leaving an effective draw-bar pull of only 1,000 pounds. A single-motor traction locomotive in which all track wheels are driven by one motor makes a much better showing on a grade because one pair of wheels can not skid, but all are forced to revolve at the same speed. But even with this style of traction locomotive, and under the most favorable conditions, the effective draw-bar pull drops off 5 per cent for each per cent of grade.

The seriousness of this decrease in the draw-bar pull becomes more apparent when one considers the need of additional draw-bar pull imposed by the grade. The draw-bar pull required to move nine cars on a level track is from 1½ to 2 per cent of their weight. Every per cent of grade up which the cars are pulled makes necessary an additional draw-bar pull of 1 per cent of the train weight. The 10-ton locomotive referred to above, with its draw-bar pull of 4,000 pounds, would, therefore on a level track pull a train weighing 200,000 pounds, on the basis of 2 per cent being allowed for draw-bar pull. If the train ran on a 1 per cent grade, the draw-bar pull of the locomotive would be reduced 5 per cent, or to 3,800 pounds, whereas the draw-bar pull required by the train would be 3 per cent of its weight, and the resulting train weight that could be pulled up this 1 per cent grade would be 126,600 pounds—a decrease of 37 per cent. If the grade became 2 per cent, the resulting train weight that could be pulled would be 90,000 pounds a decrease of 55 per cent. If the grade became 3 per cent the train weight would be reduced to 68,000 pounds; if 4 per cent, to 53,300 pounds; and if 5 per cent, to less than 43,000 pounds; or about 22 per cent of the train weight that could be hauled on the level track. These figures do not take into consideration the deleterious effects of skidding, and are, therefore, applicable only to single-motor locomotives. A two-motor locomotive would not make so good a showing as this.

It is apparent from the foregoing that for

grades there is required some form of haulage more positive in its nature than a traction locomotive, and one which does not involve moving so much dead weight up and down the grade. Such a system may be found in rope haul and in a rack locomotive. A rope haul lacks flexibility, is controlled by an engineer located at a point remote from the trip, and permits the running at very high speed. Each of these is a serious disadvantage which is eliminated by the use of locomotives, and the disadvantage is so great that there are many instances where traction locomotives are used on grades for which they are totally unfitted, in order to escape operating a rope.

The rack-rail locomotive combines the positive feature of the rope haul with the flexible features of the locomotive, and is designed to solve the haulage problem in hilly mines where the gradient is less than 15 degrees. When the gradient is greater than 15 degrees, a rope should be used, and where the haulage is level, a traction locomotive should be used.

The rack-rail haulage system consists primarily of an iron rack anchored to the ties between the rack rails, and an electric locomotive provided with sprocket wheels, which run in this rack. The rack is used in some cases as a conductor, and then takes the place of a trolley wire; in other cases it is used only for the mechanical purpose of propelling the locomotive. Two classes of locomotives are made; one of these is a plain rack-rail locomotive, designed to operate only where the rack-rail is laid. The other is a combination rack-rail and traction locomotive and is designed to run either as a rack-rail locomotive or as a traction locomotive. These locomotives are built in units of 80 H. P. and 100 H. P. When greater horse-power is required, the larger type units are run in tandem, thus making locomotives of 200 H. P.

The plain rack-rail locomotive consists of a continuous-current series-wound motor mounted on a four-wheel truck. A sprocket wheel is mounted on each axle, and revolves loosely upon it, and a train of gears connects the motor armature with the sprocket wheels. The track wheels serve only to carry the weight of the locomotive, and this weight is made no greater than is necessary to provide mechanical strength of parts, thus eliminating the great amount of dead weight carried by traction locomotives. The sprocket wheels and gears are free to move along the axle one inch either way from a central position, but are held in the central position by springs. This flexibility allows for irregularities in the relative position of the track rails and the rack.

The combination locomotives differ from the plain locomotives in that their track wheels, as well as the sprocket wheels, are driven by the motor, and they are equipped with a sanding device. When the rack is used as a conductor in place of a trolley wire the rims of the sprocket wheels are insulated from the driving hub by wood blocks, these being first treated to prevent absorption of moisture.

The rack rail consists of bar iron ⅝ in. thick, and varying in width from 4 in. to 4½ in. This is perforated with holes 1⅝ in. square, and is made up in straight pieces 16 ft. long. These 16-ft. pieces are built into a continuous rail by the use of fish-plates in a manner similar to that used in ordinary track construction.

This rack is laid between the track rails sufficiently higher than the latter to permit the points of the sprocket teeth passing over them. In those cases where it is to serve as a conductor in place of a trolley wire it is supported on wooden stringers and protected with wooden coverings. This wooden portion of the rack-rail structure consists of four parts. First: A bottom stringer which is 6¾ in. wide, and is spiked to the ties. Second: Spacing blocks which are 6¾ in. long by 4 in. wide, and are spiked to the stringer at 18-in. centers. Third: The lower covering strips which are spiked to the spacing blocks, and have a recess provided in their upper surface to receive the rack; and, Fourth: The upper covering strips which are spiked and bolted to the lower strips, and are identical in cross section with them, and which serve to hold the rack down and also protect it against accidental short circuits. In cases where the rack is used for mechanical purposes only, the bar is rolled with a bevel edge on each side, and is supported on malleable cast-iron chairs, which clamp it to a bottom stringer. The bottom stringer is similar to that used for the insulated rack, but is thicker and narrower. The iron chairs are spaced 12 in. centers and are used in pairs, the pair being held together by a bolt which serves

to clamp the chairs to the rack to permit of the track rail crossing it. At such places suitable fiittings are provided to connect together the ends of the rack by an iron bar passing under the transfer track rail. In cases where it is necessary to cut out more than 26¾ in. of rack, a throw rail or switch is provided. When the rack is used as a conductor in place of a trolley wire, an insulated bonding cable of about 250,000 circular mils. cross section is used to connect together the ends of the rack at such breaks. This makes the rack electrically continuous.

When the locomotive is a combination machine, the rack is discontinuous, being only used on grades. These discontinuous pieces of rack terminate at each end in an "approach," which is a heavy steel casting bolted securely to the rack and so shaped that it forces the sprockets to engage properly with the rack.

The rack-rail system of haulage has been successfully installed in coal mines, and there is now in daily service apparatus aggregating upwards of 15,000 H. P. The Alliance Electrical Company, Limited, of London, is making a number of these installations in the United Kingdom.

Bridge Painting.

BRIDGE painting should be done by competent men working by the day. Paint will not stick to greasy steel. If it is applied over rust, dirt, or mill scale, they come off and bring the paint with them Therefore the steel must be thoroughly cleaned, and the paint well worked into all the minute depressions in the metal, so as to thoroughly expel air, moisture and carbonic acid, all of which are necessary to produce rust. Almost any other acid, or certain salts, such as ammonium or sodium chloride, will act the same as carbonic acid, and perhaps more rapidly, but they are seldom present.

The almost universal vehicle for paint is linseed oil. Some others have been used, but I have been unable to obtain much reliable information about them. Linseed oil hardens by oxidation. If it is applied pure the oxidation makes it somewhat porous. Pure raw oil hardens slowly, and is not a very efficient covering on account of its porosity, but paint adheres well to it. Boiled oil contains a drier. The best driers are certain compounds containing manganese dioxide, lead oxide, or some other inert substance that parts with its oxygen readily. This oxidizes and hardens the oil. The coating is not so porous as raw oil, but it is not so tough and its brittleness extends to subsequent coats of paint which may be applied. On account of its porosity, as well as for other reasons, linseed oil requires a pigment mixed with it.

For priming, one of the best pigments is red lead. It is an efficient drier itself and can be mixed with raw oil without other drier. It seems to give up its oxygen to the oil, and to absorb oxygen from the air to replace it, so that it does not fade. It turns dark when exposed to sulphurous gases and makes the oil somewhat brittle, so it is not good for an outside coat, but it adheres very closely to the metal and makes an excellent foundation for other paints. The principal objections to it are the tendency to settle in the paint pot and to run when applied to a vertical surface. These difficulties are more or less successfully overcome by some manufacturers, but their methods are secret and I have no reliable information as to their value. I am informed that a moderate admixture of lampblack obviates the difficulty to a large extent.

Graphite is an excellent pigment. It is absolutely inert and unaffected by gases and other chemicals. It has great covering power and good body, that is, it is very opaque. It requires a drier as it contains no oxygen. It contains a considerable proportion of impurities, but they, so far as I know, are harmless. It is also rather cheap.

White lead has been used for centuries and is an excellent pigment. It settles more rapidly than graphite, but not so rapidly as red lead. It requires a certain amount of drier, but not so much as graphite. It becomes chalky and rubs off in time and turns dark on exposure to sulphurous gases. It has great covering power and body.

Lead sulphate is used considerably. This is not affected by sulphurous gases, but it has less body than white lead.

White zinc is a good pigment, but if used pure, is liable to peel off. It is usually mixed with white lead in about the proportion of three parts of white lead to two parts of white zinc. It is not affected by sulphurous gases.

Lampblack is a fine pigment. It resembles graphite, but is finer, lighter, more opaque and more expensive.

Chrome yellow is used with other pigments, but seldom alone. It is much more opaque than yellow ochre, but like other lead pigments turns dark on exposure to sulphurous gases. It should not be mixed with any pigment that is a sulphide for the same reason. It is rather expensive.

Iron oxide is a very cheap paint and a good one if carefully made and of good material. It does not settle, run, nor fade to any troublesome extent, and is not affected by sulphurous gases.

Turkey red, yellow, ochre, umber, sienna, venetian red and some others are composed mostly of iron oxide with a large admixture of clay, sand, and other earthly matter. They have much the same properties as the iron oxide paint mentioned above. They are rather inferior in opacity.

There are many other pigments used, but most of them are rather expensive and are employed principally for timing other colors.

Driers must be used, to a greater or less extent, with all pigments except red lead, but use as little as practicable. Too much drier makes the paint brittle. Benzine and turpentine are not properly driers at all, they are only volatile dilutents and should not be used on outside work. They tend to disintegrate the paint.

The most effective method for cleaning steel preparatory to painting is by the sand blast In the shop or yard it is little if any more expensive than hand cleaning, but is more expensive on bridges after erection. It cannot be used on city bridges above the roadway It removes, to a considerable extent, the minute depressions that are difficult to fill in painting. Steel cleaned by sand blast must be painted immediately, because it rusts very quickly

The life of a steel structure is comparatively brief in many places, for example, where exposed to salt spray, sulphurous or other acid gases from the smoke stacks of locomotives. In these places paint is not an adequate protection The ore dust emitted from some of the blast furnaces in this vicinity seems to corrode steel very rapidly. Whether this is due to sulphurous acid or to oxygen occuled in the dust or to other causes, I am not prepared to say, but the fact is beyond dispute.

It is pretty well established that steel rusts more rapidly than iron. It was suggested by a prominent chemist that that might be due to the manganese in the steel. If so, it might be due to some catalytic action that manganese may take in the case.

DISCUSSION.

K. A. Muellenhoff: In a certain mill in Germany we found the cleaning of steel, by a sand blast, to cost about the same as hand work, but hand work is a good deal cheaper there. But we had to stop its use as it weakened the rivet heads. For this class work, as railroad bridges, the following method of cleaning is generally specified now: After the parts have been assembled, the whole member, e. g., a plate girder, is placed in a tank filled with a thin solution of hydrochloric or sulphuric acid. This removes all rust and scale and gives a perfectly clean metallic surface. As soon as this is done, the piece is lifted out, rinsed with water from a hose, and in order to be sure that all the acid is neutralized, it is put in a second tank filled with limewater and left there for a couple of minutes. Then it is taken out, rinsed again, and put into a third tank filled with hot water. As soon as it is taken from that it is perfectly clean and becomes dry in a very few minutes. Then the first coat of paint is applied, consisting of linseed oil with 10 per cent of zincwhite. Before shipment it gets a coat of red lead. A second coat of red lead is given after erection, which is protected by at least two coats of some other paint. This process is little expensive, but it gives excellent results.

Thos. H. Johnson: I have very little sympathy with the use of sand blast for cleaning metal structures. You cannot do it out of doors, particularly in wet weather, because the rust will follow right behind the sand blast, and the painters must be kept working right in the cloud of dust if you are going to keep it from rusting. And then it is very apt to work under the rivet heads and loosen the rivets.

E. K. Morse, Member: I am convinced, from observation of my work, that we have come to a point in the use of steel in exposed places, such as bridges and structures exposed to the air and climatic conditions of this latitude, where we must carefully consider its use. I am satisfied that steel, as now manufactured, and used, even with careful attention to painting, will not give reasonable satisfaction in exposed positions, but is entirely satisfactory when protected from the weather.

I am satisfied that we will either have to re-

turn to wrought iron, or we will have to use some combination in the manufacture of steel. It is possible that the introduction of a small percentage of nickel in wrought iron would increase the elastic limit sufficiently to meet the demands of the engineer for a material with a high elastic limit.—*The Railway and Eng. Review.*

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*From a paper by Willis Whited, read before the Engineer's Society of Western Pennsyvania.

Standardization in British Engineering.

THE work of the Engineering Standards Committee, which has been one of the most important developments in British engineering in the past five years, was discussed at length in a paper presented by Sir John Wolfe Barry at the recent York, England, meeting of the British Association for the Advancement of Science. From the original work which the committee undertook, the preparation of standards for iron and steel sections, its field has broadened until it now includes 30 different subjects, calling for the preparation of 75 different specifications and reports. The secretary of the committee visited the United States in the fall of 1904 and met with Committee A of the American Society for Testing Materials, this committee having in charge standard specifications for iron and steel. In reporting to the Engineering Standards Committee the results of this conference the secretary said that without doubt a closer co-operation with the American Society for Testing Materials would lead to a harmonizing of methods of testing and, while the practice permitted it, of specifications. The essential differences in practice, he added, would prevent any complete harmonizing of sections and specifications.

Since the organization of the British committee in 1901 it has created 12 sectional committees, and these have appointed 24 subcommittees. The expenses of the work have been borne by the five leading engineering societies in Great Britain, the Government and leading manufacturing and railroad companies. Referring to the results of the committee's work, Sir John Wolfe Barry enumerates the sizes of structural shapes decided on for each form of material, as below, which, it will be seen, constitute a larger number than American manufacturers roll. At leading mills in the United States but 17 sizes of beams are rolled, and the standard sizes of channels are limited to 10:

The committee have laid down 16 sizes of equal angles, 30 of unequal angles, 20 of bulb angles, 6 of bulb tees, 7 of bulb plates, 8 of Z bars, 27 of channels, 30 of beams and 20 of tees. Besides the above there are, advancing by 5 lb. at a time, 9 sizes of bull-headed rails from 60 to 100 lb. per yard, 17 sizes of flat-bottomed rails from 20 to 100 lb. per yard, and 5 sizes of tramway rails from 90 to 110 lb. per yard, with their corresponding sections having a wider groove for use on curves.

The paper recognizes that standardization may not be pushed too far without impairing design or retarding progress in invention, though emphasis is laid on the statement that it is only in exceptional cases that for some particular form of angle or channel the expense entailed in cutting special rolls and the time lost in changing rolls are justified. The author continues:

In the case of steel standard sizes are also very valuable to trade, as they avoid the necessity of cutting new rolls. They can be rolled to stock, thus obviating any interruption in process of manufacture or delay in delivery. As a practical illustration the testimony of a large steel maker in Scotland may be cited, who admits that since the introduction of standard sizes his firm has been able to break up some hundreds of tons of rolls, and by no means the least advantage gained is that in his works the process of manufacture is now no longer so constantly interrupted as it used to be, due to the frequent changing of the rolls to produce in smaller quantities the many special sizes asked for, without any corresponding advantage to the consumer.

A further striking illustration of the advantages of standardization occurred in connection with the construction of the tramways of a large Midland city. An order for the rails—to be made in conformity with the British standard specifications—was, in the first instance, placed with a Continental firm. From want of expedition and punctuality in making deliveries, and from failure to comply with the stipulated tests, etc., the corporation and their contractors were placed in a position of considerable difficulty by the constructional work being brought to a standstill. This

caused them to approach a British firm, who, having the "standard" rolls already cut, undertook to make a delivery within a few days, with the result that the Continental order was cancelled and transferred to the British firm. Altogether orders have already been received for nearly 100,000 tons of these standard rails, probably representing a value of over half a million of money. Practically all the British firms of tramway rail makers are now equipped with sets of rolls for the standard sections and they are thus enabled to deliver such rails at very short notice, instead of the general experience heretofore of having to spend several weeks in the preparation of new rolls. This is not only a great advantage to the purchaser, but also a considerable saving in expenditure to the maker, as the cutting of a set of rolls usually costs about £200.

With a view of introducing standardization in its most efficient and stable form the committee has decided to establish at the National Physical Laboratory at Bushy a series of gauges and templates to which all the templates throughout the country can be referred, and from time to time checked.

In the discussion on the paper Sir William Preece illustrated the money value of standardization by instances drawn from the manufacture of electrical plant in this country. Of the 472 electrical installations now running in this country only one-fifth are provided with standard types of motive or generating machinery, and the capital cost of the plant in the remaining 378 installations has been enormously increased by the multiplicity of types employed. Exception was taken by Sir William White to the inference carried by this statement. He could not agree that standardization was required in the electrical industry, believing this to be an instance in which too early standardization of plant and machinery would check legitimate invention and progress.—*Iron Age.*

Track Construction in Mines.

BY LEO GLUCK.*

TRACK construction in mines in the last few years has received more attention and care than formerly. The recognition of the advantage of loading the mine cars to capacity, the increased speed of haulage, together with the installation of motors, have been the prime factors for the providing of better track construction.

The limitation of space for the mine tracks and car clearance necessitates the use of curves of small radii, large frog angles, cars with small wheels and short wheel base; all different from the usual surface railroad practice.

The only tendency in modern mine work has been the using of heavier rails, keeping the gauge more rigid and also the bending of curves and turnouts with modern and proper appliances.

Where double tracks are used, the track centers owing to space limitations are such that the distance between the two inner rails is usually less than gauge, so that when double crossings or turnouts are necessary the layout becomes special and complicated.

In mines operated by double compartment hoisting shafts, where there are parallel tracks on each side of the shaft landing, one of them, usually the right hand one, is for storage of loaded cars, the other for the empty cars. From each right hand track, on its corresponding side of the shaft, loaded cars are run on the cage which push the empties from the cage to the opposite side of the shaft to the storage track for empty cars. If for any cause one or the other loaded car tracks is blocked, so that the cars from that side cannot be loaded on the cage, the empty car of course can be taken from the cage to the track for empties; but in order to place a loaded car on the cage opposite the empty track, a double or diamond cross-over switch is used on both sides of the shaft landing. Cars can then be crossed from either one of the tracks to the other.

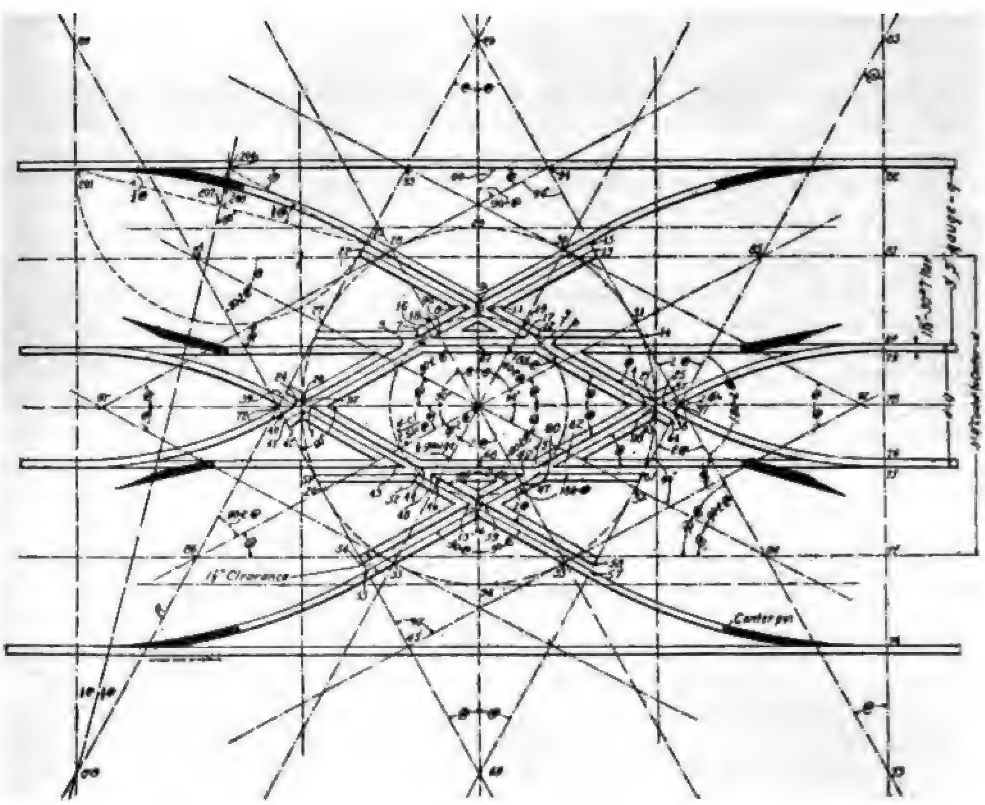
The main advantage of the cross-over switches is that the supply of empties on each side of the shaft can then be regulated without crossing from one of the landings to the other, or "cross caging," in case one or the other of the tracks become blocked. In modern tipples the diamond switches are used to advantage, being placed between the shaft and the weighing and also the dumping apparatus. In case of a disarrangement of the weighing or dumping appliances, the cars can be crossed from one track to the other and all without delaying the hoisting in the shaft.

The double cross-over or diamond switch, in general, for mine work, consists of two parallel tracks connected by circular curves.

It differs from the double crossing of railroad practice for the reason that the distance between the two inner rails is usually less than the gauge of the tracks, so that the diamond part of the crossing is included, in part, inside of the gauge of the parallel tracks, while in railroad practice the diamond is always completely included between the two inner rails, and, therefore, is a true diamond and very simple and always the same for the same frog angle and independent of the gauge of the tracks and the distance between parallel track centers.

the distance between track centers as well as the gauge of the track, so that the turnout radius, other conditions being fixed, determines the distance between track centers.

The frog angle has certain limitations. As the frog angle increases, the radius of the turnout curve decreases, the limitation being the ease with which cars of a certain wheel base can go around the curve. As the frog angle decreases, the radius of the turnout increases, the limitation being that the turnout becomes too long, thereby requiring too long a time in making the crossing; also



In the design of the diamond switch or cross-over the gauge of the parallel tracks is given as g, the distance between centers of tracks is d, the frog angle is taken as a. The gauge of tracks is determined by the size of the roadways, and this, in part, fixes the size of the hoisting shaft. The distance between track centers is fixed by the size of the hoisting compartments in the shaft; but, as will be shown later in the trigonometric formula, the *radius of the turnout* curve is dependent on increasing that part of the crossing at a corresponding loss of car shortage on each side of the shaft landing.

In the design of a double diamond cross-over, the aim is, after having the gauge and track centers determined, to then define the frog angles so that the radius of the turnouts is large enough to allow the cars to pass from tangent to curve and curve to tangent with a minimum of effort, and with a minimum of shock, as mine cars are usually built

up with coal over the tops of the car box; in an improperly designed crossing this topping would jar off the car. Also, with the foregoing in mind, the aim is to retain as much space as possible for coal storage, which is lost by making the cross-over too long.

The general and graphical solution is shown in the accompanying etching. Lay off the tracks as in figure, with gauge *g*, track centers, *d*, and frog angle *a*. Draw line *91-78* parallel to and midway between the empty and loaded side-tracks. At *100* draw *69-70* perpendicular to *91-78*. Point *100* is to be the center of the diamond frog construction. With *100* as a center, describe a circle with radius one-half *g*. Through point *100*, draw *19-100-46* and *18-100-47*, each making an angle, *a*, with the line *69-100-70*. Through *100*, at right angles to the lines *19-100-46* and *18-100-47*, respectively, draw *27-100-32* and *26-100-31*. As the angles laid off first were *a*, then the others become *a* and *90-2a*.

The circle with *100* as a center and a diameter of *g* must have the tracks of both crossings tangent to this circle. The points *18*, *19*, *46*, and *47* are determined by the intersection of the lines *19-100-46* and *18-100-47* with the circle whose diameter is *g* and center is at *100*. The points *5*, *6*, *43*, *62*, are determined by drawing tangents to the circle at *18*, *19*, *46*, and *47*, respectively, and finding the intersection with the inside rails of the side tracks. With *100* as a center, and a radius

$$r = \frac{g - cl}{2 \sin a},$$

describe a circle; this determines *27*, *31*, *26*, *32*, *97*, and *98*, respectively; and by drawing tangents at the several points *23*, *15*, *55*, and *57* are determined, also *41* and *64*, *20*, and *42*, and *21* and *63*. Extend *9-23* to *204*; then with *204* as a center, and with a radius of *23-204*, determine point *201*. At *201* draw *201-88* perpendicular to the track; the intersection of *70-27* extended determines the point *88*, or the radius of the outer turnout rail. The point *203* is determined by the radius *R*, but for the bending of rails it is taken at one-half of *207-204*.

The following shows the trigonometric relation of the various parts of the diamond, or double cross-over, switch, in general; by substitution for given values the diamond can be built without the usual method of "laying out" or drawing to scale. The whole or parts

$$(86\text{-}89) = (20\text{-}1) = (1\text{-}42) = (42\text{-}24) = (8\text{-}9) = (9\text{-}11) = (11\text{-}10) = (10\text{-}8) = \frac{cl}{2 \sin a \cos a}$$

$$(1\text{-}2) = (1\text{-}44) = (3\text{-}4) = (4\text{-}45) = (24\text{-}5) = \frac{d - g}{2 \sin a}$$

$$(29\text{-}97) = \tfrac{1}{2}(20\text{-}42) = \tfrac{1}{2}(9\text{-}10) = \frac{cl}{2 \cos a}$$

$$(24\text{-}97) = (97\text{-}1) = \tfrac{1}{2}(24\text{-}1) = \tfrac{1}{2}(15\text{-}2) = \tfrac{1}{2}(7\text{-}5) = \tfrac{1}{2}(7\text{-}16) = \tfrac{1}{2}(16\text{-}2) = \tfrac{1}{2}(8\text{-}11) = \frac{cl}{2 \sin a}$$

$$(1\text{-}100) = (100\text{-}4) = \frac{\frac{g}{2} - cl}{\sin a}$$

$$(1\text{-}4) = \frac{g - 2cl}{\sin a}$$

$$(20\text{-}5) = (24\text{-}5) - (24\text{-}20) = \frac{d - g}{2 \sin a} - \frac{cl}{2 \sin a \cos a}$$

$$(9\text{-}100) = \tfrac{1}{2}(9\text{-}56) = \frac{g}{2 \cos a}$$

$$(28\text{-}100) = (9\text{-}100) - (9\text{-}70) = \frac{\frac{g}{2} - cl}{\cos a}$$

$$(10\text{-}30) = \frac{g - 2cl}{\cos a}$$

$$(24\text{-}100) = (1\text{-}100) + (24\text{-}1) = \frac{g}{2 \sin a}$$

$$(24\text{-}25) = (6\text{-}204) = \frac{g}{\sin a}$$

$$(9\text{-}67) = (9\text{-}100) - (100\text{-}67) = \frac{g}{2 \cos a} - \frac{(d - g)}{2}$$

$$(5\text{-}6) = \frac{g - (d - g) \cos a}{\sin a}$$

$$r = (1\text{-}100) + (1\text{-}97) = \frac{g - cl}{2 \sin a}$$

$$(9\text{-}18) = \frac{g \tan a}{2}$$

$$(9\text{-}15) = r - (9\text{-}18) = \frac{g - cl}{2 \sin a} - \frac{g \tan a}{2}$$

$$(5\text{-}9) = \frac{(9\text{-}67)}{\sin a} = \frac{g}{2 \sin a \cos a} - \frac{(d - g)}{2 \sin a}$$

$$(5\text{-}15) = (5\text{-}9) + (9\text{-}15) = \frac{g}{2 \sin a \cos a} - \frac{d + cl}{2 \sin a} + \frac{g}{\sin a} - \frac{g \tan a}{2}$$

$$(72\text{-}100) = \frac{g - cl}{2 \sin a \cos a}$$

$$(72\text{-}27) = (72\text{-}26) = \frac{g - cl}{2 \cos a}$$

$$(72\text{-}24) = (72\text{-}100) - (24\text{-}100) = \frac{g - cl}{2 \sin a \cos a} - \frac{g}{2 \sin a}$$

$$(100\text{-}91) = (100\text{-}70) = \frac{g - cl}{2 \sin^2 a}$$

$$(100\text{-}57) = \frac{d}{2 \sin a}$$

$$(23\text{-}204) = (6\text{-}204) - (6\text{-}23) \text{ or } (5\text{-}15)$$
$$= \frac{d + cl}{2 \sin a} - \frac{g}{2 \sin a \cos a} + \frac{g \tan a}{2}$$

$$(72\text{-}30) = (72\text{-}24) \sin a = \frac{g - cl}{2 \cos a} - \frac{g}{2}$$

$$(30\text{-}24) = (72\text{-}24) \cos a = \frac{g - cl - g \cos a}{2 \sin a}$$

$$(41\text{-}42) = \frac{g - g \cos a}{2 \sin a}$$

$$R = \frac{(23\text{-}204)}{\tan \frac{1}{2} a} = \frac{d + cl - g \cos a}{2(1 - \cos a)}$$

$$(9\text{-}204) = (6\text{-}204) - (5\text{-}9) \text{ or } (6\text{-}9) = \frac{d + g}{2 \sin a} - \frac{g}{2 \sin a \cos a}$$

$$(204\text{-}303) = (9\text{-}204) \cos a = \frac{d - g + g \cos a}{2 \sin a}$$

$$(303\text{-}201) = (303\text{-}204) + (23\text{-}204)$$
$$= \frac{d}{\sin a} + \frac{cl + g \cos a - g}{2 \sin a} - \frac{g}{2 \sin a \cos a} + \frac{g \tan a}{2}$$

$$(207\text{-}204) = (23\text{-}204) \sin \tfrac{1}{2} a$$
$$= \left[\frac{d + cl}{2 \sin a} - \frac{g}{2 \sin a \cos a} + \frac{g \tan a}{2}\right] \sin \tfrac{1}{2} a$$

$$(23\text{-}207) = \frac{(207\text{-}204)}{\tan \frac{1}{2} a} = \left[\frac{d + cl}{2 \sin a} - \frac{g}{2 \sin a \cos a} + \frac{g \tan a}{2}\right] \cos \tfrac{1}{2} a$$

$$(201\text{-}88) = (d + g) \cot a + \frac{d + cl - g}{\sin a} - \frac{g}{\sin a \cos a} + g \tan a.$$

Note.—cl = clearance

can be cast from patterns or built from templates.—*Mining World.*

*Chief Engineer Spring Valley Coal Co., Spring Valley, Illinois

THE DESIGNER AND DRAFTSMAN.

The Art of Inventing.

BY EDWIN J. PRINDLE.

[A paper presented at the 23rd annual convention of the American Institute of Electrical Engineers, Milwaukee, Wis., May 28-31, 1906. Copyright, 1906, by A.I.E.E.]

There are many kinds of invention. The poet, the artist, the playwright, the novelist all exercise or may exercise invention in the production of their works. The merchant may exercise invention in the devising of a new method of selling goods. The department store was an invention of this class.

The subject of my paper is, however, the art of making technical inventions, and particularly patentable inventions. And, first, of its commercial importance; for the engineer is concerned with things having a commercial value. By the art of inventing, wealth is created absolutely out of ideas alone. It usually takes capital to develop an invention and make it productive, but not always. A notable recent example is Professor Pupin's loaded telephone line. He received a very large sum of money, and his expenditures, as I understand, were comparatively trivial.

The certificate of ownership of an invention is a patent, and the importance of the art of invention will be made apparent from a brief consideration of what rights a patent confers and of the part that patents play in the industries.

A patent is the most perfect form of monopoly recognized by the law. As was said in a recent decision:

"Within his domain, the patentee is czar. The people must take the invention on the terms he dictates or let it alone for seventeen years. This is a necessity from the nature of the grant. Cries of restraint of trade and impairment of the freedom of sales are unavailing, because for the promotion of the useful arts the constitution and statutes authorize this very monopoly."

There is an enormous amount of wealth in this country that is based upon patents. As an instance, might be mentioned the fact that the *United Shoe Machinery* Company is, by means of patents, able to control the sewing machines upon which ninety per cent. of the welt shoes in the United States are sewed. The Bell Telephone Company, and the Westinghouse Air Brake Company and many other corporations of the first importance built themselves up on patents. Patents have become so well recognized a factor in commerce that, in many lines of manufacture, concerns do not depend simply upon cheapness of manufacture, or quality of product, to maintain their trade, but they count on always having a product which is at least slightly better than that of their competitors, and which is covered by patents, so that they do not have to compete with an article of equal merit. And they keep a corps of inventors at work in a constant effort to improve the product, so that, when the patents now giving protection have expired, they will have a better article to offer, which shall also be protected by patents.

Inventing has become almost a recognized profession. Many large concerns constantly employ a large corps of inventors, at liberal salaries. Besides the inventors employed by large corporations, there are many inventors who have maintained their independence, and are free lances, so to speak. Some inventors have become wealthy almost solely by their inventions, such as Edison, Bell, Westing-

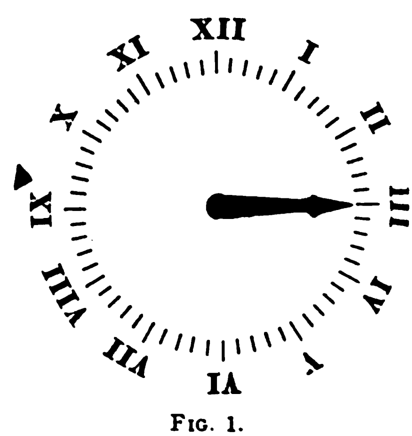


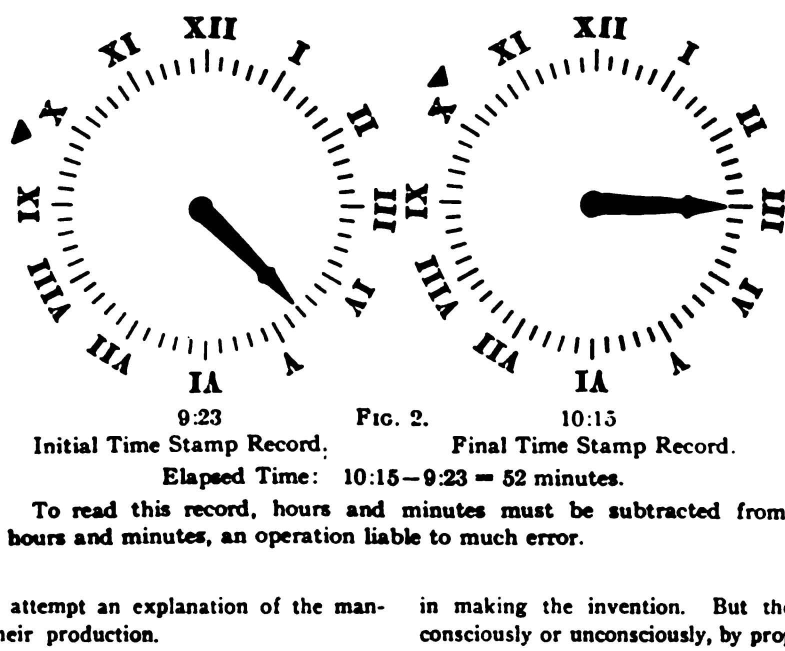
FIG. 1.
Time Stamp Record.

house, Marconi, Pupin, Tesla and Sprague. A considerable number of the smaller manufacturing concerns are built largely or wholly upon the inventions of their principal owners.

Aside from the question of financial returns from inventing, the inventor has the satisfaction of knowing that he is a producer of the most fundamental kind. All material progress has involved the production of inventions. Inventors are universally conceded to be among the greatest benefactors of the human race.

The art of invention is therefore one of great commercial and economical importance, and it becomes a matter of much interest to know how inventions are produced. It is my inventive act, it can, so to speak, clear the way and render the inventive act easier of accomplishment.

Invention has been defined as "In the nature of a guess; the mind leaps across a logical chasm. Instead of working out a conclusion, it imagines it." The courts have repeatedly held that that which could be produced *purely* by the process of reasoning or inference, on the part of one ordinarily skilled in the act is not patentable, but that the imaginative or creative faculty must somewhere be used in the process. The mind must somewhere leap from the known to the unknown by means of the imagination, and not by mere inference



9:23 FIG. 2. 10:15

Initial Time Stamp Record. Final Time Stamp Record.

Elapsed Time: 10:15 − 9:23 = 52 minutes.

To read this record, hours and minutes must be subtracted from hours and minutes, an operation liable to much error.

object to attempt an explanation of the manner of their production.

If it be inquired on what grounds I offer an explanation of this apparently most difficult subject, I reply that, in the practice of patent law, I have often had occasion and opportunity to inquire into the mental processes of inventors, and that the subject is one to which I have given considerable attention.

It seems to be popularly believed that the inventor must be born to his work, and that such people are born only occasionally. This is true, to a certain extent, but I am convinced there are many people who, without must have some imagination or creative faculty, but, as I shall seek to show, this faculty may be greatly assisted by method. While reasoning does not constitute the whole of an in making the invention. But the inventor, consciously or unconsciously, by proper method reduces the length of this leap to much more moderate proportions than is popularly supposed.

That reasoning and research frequently enter very largely into the inventive act in aid of the creative faculty is the opinion of Dr. Trowbridge, of Columbia University who said:

"Important inventions leading to widespread improvements in the arts or to new industries do not come by chance, or as sudden inspiration, but are in almost every instance the result of long and exhaustive researches by men whose thorough familiarity with their subjects enables them to see clearly the way to improvements. Almost all important and successful inventions which have found their way

into general use and acceptance have been the products of well-balanced and thoughtful minds, capable of patient laborious investigation."

Judge Drummond, in a decision many years ago, said:
suspecting it, have latent inventive abilities, which could be put to work if they only knew how to go about it. The large percentage of inventors in this country compared with all other countries, shows that the inventive faculty is one which can be cultivated to some extent. The difference in ingenuity is not wholly a matter of race, for substantially the same blood exists in some other countries, but it is the encouragement of our patent laws that has stimulated the cultivation of this faculty.

a color which does not consist of a blending of one or more colors with which we are already familiar. This evolution of an invention is more or less logical, and is often worked out by logical processes to such an extent that the steps or efforts of imagination are greatly reduced as compared with the effort of producing the invention solely by the imagination.

Edison is quoted as having said that "any man can become an inventor if he has imagination and pertinacity," that "invention is not so much inspiration as perspiration."

There are four classes of protectable inventions. These are

Arts,
Machines,
Manufacturers, and
Compositions of matter.

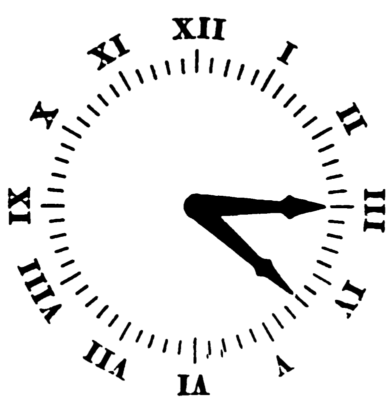


FIG. 3

Subtraction eliminated but counting still required, and uncertainty whether elapsed period is 7 or 53 minutes.

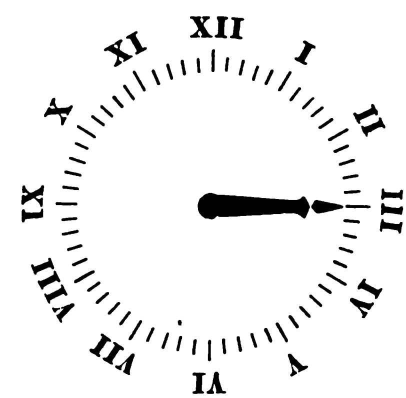


FIG. 4.

Hand and zero mark revolving within stationary dial.

The popular idea seems to be that an invention is produced by its inventor at a single effort of the imagination and complete, as Minerva sprang full grown and fully armed from the mind of Jove.

It is, undoubtedly, true that every inventor
"Most inventions are the result of experiment, trial, and effort, and few of them are worked out by mere will."

Most inventions are an evolution from some previously invented form. It has been said:

"We know exactly how the human mind works. The unknown—or unknowable—it always conceives in terms of the known."

Even the imagination conceives in terms of what is already known; that is, the product of the imagination is a transformation of material already possessed. Imagination is the

In popular language an art may be said to be any process or series of steps or operations for accomplishing a physical or chemical result. Examples are, the art of telephoning by causing undulations of the electric current corresponding to the sound waves of the spoken voice. The art of casting car wheels, which consists in directing the metal into the mold in a stream running tangentially instead of radially, so that the metal in the mold is given a rotary movement, and the heavy, sound metal flows out to the rim of the wheel, while the light and defective metal is displaced toward the centre, where it is not subjected to wear.

The term machine hardly needs any explanation. It may be said to be an assemblage of two or more mechanical elements, having a law of action of its own.

A manufacture is anything made by the hand of man, which is neither a machine nor a composition of matter; such as, a chisel, a match, or a pencil.

The term composition of matter covers all combinations of two or more substances, whether by mechanical mixture or chemical union, and whether they be gases, fluids, powders or solids; such as, a new cement or paint.

These definitions are not legally exact, but serve to illustrate the meaning.

In the making of all inventions which do not consist in the discovery of the adaptability of some means to an end not intentionally being sought after, the first step is the selection of a problem. The inventor should first make certain that the problem is based upon a real exist, and in fact discovering the presence of faults which are not obvious to others, because of the tendency to believe that whatever is, is right.

Then the qualities of the material, and the laws of action under which one must operate should be exhaustively considered. It should be considered whether these laws are really or only apparently inflexible. It should be carefully considered whether further improvement is possible in the same direction, and such consideration will often suggest the direction in which further improvement must go, if a change of direction is necessary. Sometimes the only possible improvement is in an opposite direction. A glance at the accounts of how James Watt invented the condensing steam-engine will show what a large part profound

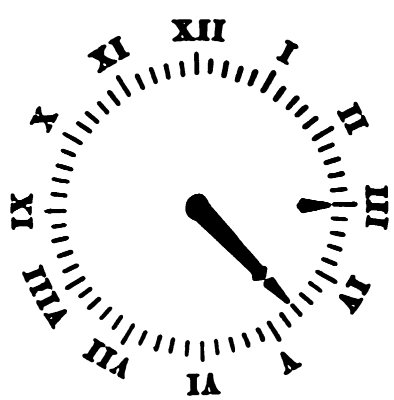


FIG. 5.

Initial imprint of zero mark alone and final imprint of hand (and zero). Elapsed time, 8 minutes. No subtraction and no uncertainty as to which imprint first, but counting still required.

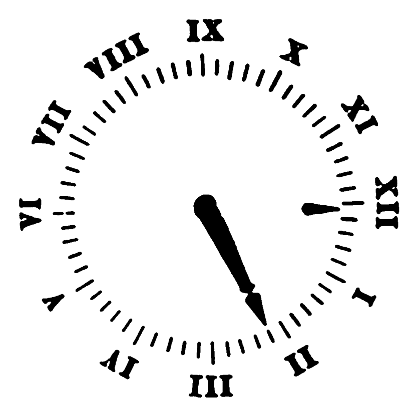


FIG. 6.

Dial moved up to initial position of zero mark. Elapsed time, 11 minutes. No subtraction, no counting, no uncertainty; but only one record possible at a time.

association in new relations of ideas already possessed by the mind. It is impossible to imagine that, the elements of which are not already known to us. We cannot conceive of need. Much time and money is sometimes spent in an effort to invent something that is not really needed. What already exists is good enough or is so good that no additional cost or complication would justify anything better. The new invention might be objectionable because it would involve counter disadvantages more important than its own advantages, so that a really desirable object is the first thing to be sure of.

Having selected a problem, the next step should be a thorough analysis of the old situa- [illegible] reasons for the faults which study of the old engine and of the laws of steam played in his invention, and how strongly they suggested the directions of the solutions of his difficulties.

We now come to the constructive part of inventing, in order to illustrate which, I will seek to explain how several inventions were, or could have been, produced.

The way in which the first automatic steam engine was produced was undoubtedly this— and it shows how comparatively easily a really great invention may sometimes be made. It was the duty of Humphrey Potter, a *boy*, to turn a stop-cock to let the steam into the cylinder and one to let in water to condense it at certain periods of each stroke of the engine and if this were not done at the right

time the engine would stop. He noticed that these movements of the stop-cock handles took place in unison with the movements of certain portions of the beam of the engine. He simply connected the valve handles with the proper portions of the beam by strings, and the engine became automatic—a most eventful result.

As one example of the evolution of an invention, I will take an instrument for measuring and recording a period of time, known as the calculograph, because it lends itself with facility, to an explanation from a platform and because my duties as a lawyer have necessitated my becoming very familiar with the invention, and have caused me to consider how it was probably produced.

And first the problem: There was much occasion to determine and record the values of periods of elapsed time; such as, the length of time of a telephone conversation; as the revenue of the telephone companies depended upon the accuracy of the determination. All the previous methods involved the recording in hours and minutes the times of day, marking the initial and the final limits of the period to be measured, and then the subtraction of the one time of day from the other. This subtraction was found to be very unreliable as well as expensive. The problem then was to devise some way by which the value of the period could be arrived at directly and without subtraction and also by which such value could be mechanically recorded.

The prior machine from which the calculograph was evolved is the time-stamp, a printing machine having a stationary die like a clock dial and having a rotating die like the hand of the clock, as in Fig. 1. The small triangle outside the dial is the hour hand, it being placed outside the dial because it is necessary that the two hands shall be at the level of the face of the dial and yet be able to pass each other. The hour hand may be disregarded here, as the records needed are almost never an hour long. The manner of using the time stamp to determine the value of an interval was to stamp the time of day at the beginning of the period, and then to stamp the time of day at the close of the period at another place on the paper, as shown in Fig. 2, and finally mentally to subtract the one time of day from the other to get the value of the period.

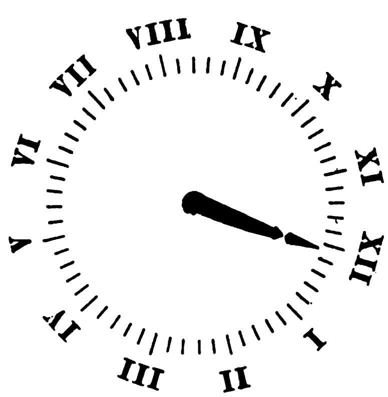


FIG. 7.
Dial with pointer at zero revolving together.

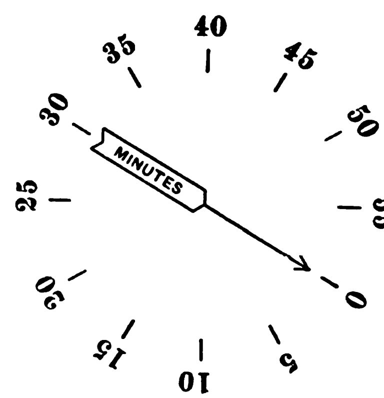


FIG. 8.
Dial with pointer at zero revolving together, zero mark on pointer being replaced by zero of dial.

The inventor of the new machine conceived the idea that, if the time-stamp were provided with guides or gauges so that the card could be placed both times in the same position, and the two records of the time stamp thus be superimposed concentrically (as illustrated in Fig. 3), the value of the period would be represented by the arc marked off by the initial and final imprints of the minute hand, so that, instead of subtracting one record from another, he had only to find the value of the arc marked off by counting the corresponding number of minutes along the dial.

The inventor had thus gotten rid of the subtraction, but there were several desirable qualities not yet obtained. First, he could not tell from the record alone, whether it was the longer or the shorter arc marked off that was the measure of the period. For instance, he could not tell whether the period was 7 or 53 minutes. This was because the two hand or pointer imprints were exactly alike except in

position. So he conceived the idea of making the pointer imprints different in appearance, by providing the pointer die with a mark in line with the pointer, as illustrated in Fig. 4.

The mark and pointer revolve together and either the dies or the platen are so arranged that the mark can be printed without the pointer at the initial imprint and the pointer at the final imprint as in Fig. 5, the mark being printed or not at the final imprint, as desired. This could be done either by allowing the pointer die or the corresponding portion of the platen to remain retracted from the paper during the first printing.

It could thus be told with certainty from the record alone whether the longer or the shorter arc is the measure of the period, because the beginning of the arc is that indicated by the imprint of the mark without the pointer.

There was still something to be desired. The counting of the minutes along the measuring arc was a waste of time, if the value of the arc could in some way be directly indicated. If the hand were set back to 12 o'clock for the initial imprint, the final imprint would show the hand pointing directly at the minute whose number on the dial is the value of the period and it would not even be necessary to count. But the setting of the hand back to zero would prevent its making the final imprint of any previously begun record, so that the machine could only be sued for one record at a time. It was desirable to have a machine that would record any number of overlapping intervals at the same time, so that one machine would record the intervals of all the telephone conversations under the control of a single operator, or rather of two operators, because both of them could reach the same machine. So it wouldn't do to set the hand back to zero, as the hand must rotate constantly and uniformly. Then why not set the zero up to the hand at each initial imprint? This meant making the dial rotatable, as well as the hand. It gave an initial record like that shown in Fig. 6.

The inventor then thought of securing the dial to the pointer die so that they would revolve together, the zero of the dial being in line with the pointer, as illustrated in Fig. 7. This would obviate the necessity of setting the zero of the dial up to the pointer at the initial imprint.

But again the improvement involved a difficulty. As the dial rotated, its final impressions would never register with its initial impressions and would therefore always destroy them. As the first imprint of the dial was the only useful one, and as the second imprint only made trouble, the inventor conceived the idea of not making any imprint of the dial at the close of the period, and this he accomplished by making the annular portion of the platen covering the dial so that it could be advanced to print or not as desired. As the zero of the dial always marked the beginning of the measuring arc, it served the same purpose as the mark in line with the pointer, and the latter coulld now be omitted.

The final machine then consists simply of a revolving die which, as shown in Fig. 8, consists of a graduated and progressively numbered dial, having a pointer revolving in line

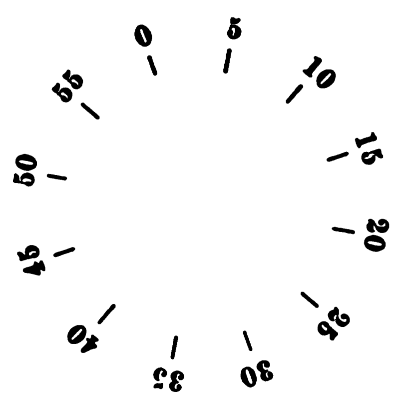


FIG. 9a.
Initial Imprint.

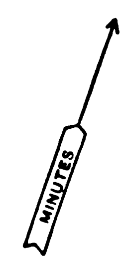


FIG. 9b.
Final Imprint.

with the zero, and the machine has a platen consisting of an inner circular portion over the pointer and an annular portion over the dial, each portion being operated by a separate handle so that the dial can be printed at the beginning of the period and the pointer alone, at its close.

The final record has an initial imprint of the dial. Fig. 9a, the zero of the dial showing the position of the pointer at the beginning of the period, and a final imprint of the pointer alone, as shown in Fig. 9b, the complete final record, Fig. 9c, consisting of the superimposition of these two records, and showing the pointer in line with that graduation whose number is the value of the period. Here is a record not only involving no subtraction and no uncertainty but not even, counting in its record, and, as it was made without disturbing the motions either of the pointer or dial, any number of records of other periods could have been begun or finished while the machine was measuring the period in question.

Hiding all the intermediate steps in the evolution of this invention, it seems the result of spontaneous creation, but considering the steps in their successive order, it will be seen that the invention is an evolution from the timestamp; that logic rendered the effort of the imagination at any one step small by comparison, and that the individual steps might be well within the capacity of a person to whom the spontaneous creation of the final invention *might* be utterly impossible.

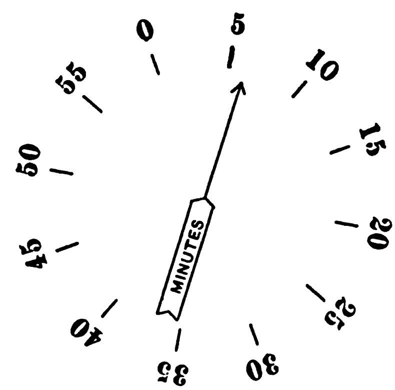


FIG. 9c.
Complete Record.

Simple, direct-reading record. No subtraction, no counting, no uncertainty. Any number of overlapping periods recorded on one machine.

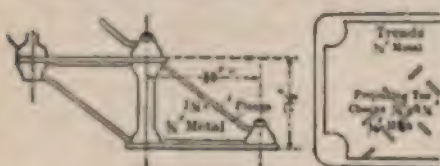
A Stairway of Adjustable Length.

The illustration shows details of a stair-horse and tread that possesses many desirable features. Mr. J. H. Granbery in *The Engineering and Mining Journal* has the idea from the engine stairways used on the Manhattan type of Allis-Chalmers engine in the elevated and subway power stations in New York City. The design is capable, however, of many modifications, making it applicable to other situations than that for which it was originally designed. Its chief recommendation aside from the cheapness and ease of construction is its adjustability to different story-hights without change in patterns or castings; so long as the story hights are multiples of whatever rise may be adopted for the stairway, the same material precisely can be used for stairs of any hight. For extremely long flights the bolts may have to be a little larger to aid in carrying the strain.

Only two patterns are required, one for the tread and another for the horses. The horses are alike on both sides and the pattern does not have to be paired. A stairway of 10-in. tread by 7½-in. rise is found to be about the easiest upon the men who have to climb it, and this is accordingly the size for which the details are given. Whatever rise and tread is adopted as standard may be used throughout the plant in all stairways if the story-hights are made multiples of the rise; and a stock of these castings and the bolts necessary for them may be kept on hand and used without

delay, such as would be required from purchasing new material whenever additions are to be made to existing works.

For story hights of not more than 15 ft. the stairway, as made, of ⅜-in. metal and with ¾-in. bolts, is amply sufficient to be self supporting throughout its length during erection. It may, therefore, be built in the manner for which it is designed by setting the first pair of horses, placing on the first tread and bolting up, continuing this process with each pair of horses and each tread. There is thus no



necessity for any shoring or support beyond the stairway itself. It might be termed a cantilever construction, in so far as its action is that of a cantilever until the upper connection to the floor is provided. The actual cost of castings and erecting does not usually exceed $1.50 per rise, or for a 15-ft. stairway, $2.50 per ft. This, of course, depends upon local conditions and upon the size adopted; the figures given are for a stairway 30 in. in width and made of ⅜-in. metal, substantially as shown in the illustration.

A Time and Trouble Saver for Topographical Draftsmen.

In the preparation of topographic maps, the draftsman is often called upon to lay off a number of offsets from one or both sides of a base line. This takes no inconsiderable amount of time and is often tedious. The extremely simple device hereinafter described is one which I have found very convenient; it can be made by any draftsman in a few spare moments and will save much time and some labor.

Take a transparent, 45° triangle of such size as is most convenient for the scales you are apt to use, lay it flat upon the drawing board and with its long edge against some true surface such as a tee square. Take another triangle, place it on top of the first with one of its edges (one of those forming the right angle) also against the tee square, and move it along until the other short leg passes through the apex of the lower triangle. Next take a knife or some other pointed instrument and scratch a line on the lower triangle using the upper as a guide. Your triangle is now marked by a line perpendicular to the long edge at its middle point and hence intersecting the two short edges at their intersection.

The use of this device is even simpler than its construction. Place it on the line from which the offsets are to be made, with the marked side downward, and with the line on the triangle coinciding with the line on the drawing. A line can now be drawn on either side or on both sides of the base line, and at right angles to it.

This simple and efficient instrument can be made in less time than it takes to describe it, and in one day's use will save its owner several times the few minutes employed in its manufacture. If ordinary care be exercised in making it, it will be sufficiently accurate for any but the finest and most exact work.

T. A. H.

Transparent Envelope for Drawings.

Mr. Robert A. Lockmann in *American Machinist*, says, "As drawings, completed or not, sent into the shop are apt to get dirty, my employer devised an envelope to prevent this."

The back is bookbinders' board about ¼-in. thick, a strip of heavy filler board is put around these edges and transparent celluloid on top. These are fastened together with escutcheon pins clinched on the back. A copper rivet and washer at each corner is put in as an extra precaution.

The drawing is slipped in or out at the open edge.

The Draftsman's Society.

Now that the cooler weather is come and the boys have returned from their vacations, more may be said about the society. The latest proposed constitution is in circular form and will be mailed to any one addressing this magazine.

Mr. A. B. Hays, of Milwaukee, the author, adds the following:

Dear Sir:—

In inviting you to become a member of our organization and to properly carry out the fraternal features of our order and for the

purpose of filling vacancies with men of undisputed reputations, we are urged to do all in our power to see that a member of the F. D. A. is given the position.

In order to carry out this feature with the highest degree of success, all members are duty bound to do their utmost to place brother members in any vacancy they may hear of.

The F. D. A. takes no part directly or indirectly in the matter of wages or contract between employer and draftsmen, and it is opposed to interference of any kind with a member or his employer.

Instead, it aims to raise the standard of the drafting profession by advocating a system of self-improvement among its members in a social, humane and professional manner.

A member who becomes sick or disabled and is incapacitated from attending to his duties, may apply to the secretary of the association for assistance and if convinced that the member merits assistance the secretary shall issue a call to every active member for a voluntary contribution to a benefit fund.

Yours respectfully,

A. B. HAYES.

Data Sheets.

Our Data Sheets this month include several tables of dimensions of flange pipe, which are the new standard adopted at a meeting of pipe manufacturers and water works supply concerns.

This is known as the "New England Standard" and except for a few very slight modification is now the standard with all the plants of the U. S. Cast Iron Pipe & Foundry Co., and other manufacturers.

The matter of standardizing of gas pipe is now under discussion and we may be able to publish tables when it is determined.

Estimating Costs.

Every designer, sooner or later will be called on to figure costs and the time feature will be the greatest obstacle to the work.

Unless he has had considerable experience he will have more difficulty in getting this information than any other.

It may surprise him to learn when the work is completed that his estimate is far off where labor is considered.

The time required to rivet up certain work on one job will not be followed on another and the manner of doing the work is different.

If the designer and estimator could prepare himself by making a collection of data relative to costs of doing a piece of work he would have something to start him thinking. The *Engineering-Contracting* often publish the cost of doing different kinds of work as the following will show.

"In connection with the operation and care of the Muscle Shoals Canal, U. S. Government Tennessee River Improvement, a small saw mill was used for sawing and planing lumber. This lumber was largely used in building and repairing boats and was usually sawed and planed just as needed. Consequently the mill was run very spasmodically, sometimes being in operation all day, and again only an hour or so. The men operating the mill were used on other work when not employed in the mill. The sawyer was paid $50 per month and helpers from $1.20 to $1.50 per day of eight hours.

During the year 1904-5 a total of 77,591 ft. B. M. of lumber were sawed at an average cost of $2.11 per M, and 56,121 ft. B. M. were planed at an average of $1.38 per M.

The lumber ranged in size from 8 ft, to 45 ft. long and from 1-in. boards to sticks 20 in. x 20 in. in cross section.

The planer, which would take a stick as large as 6 in. x 24 in., was worked by the same operatives as the saw mill.

The mill was run by a 55 h. p. Victor turbine and carried a 60-in. circular saw.

Blueprint Duty.

CANADIAN TARIFF ON ARCHITECTS' PLANS.

Consul R. S. Chilton, Jr., of Toronto, advises that the Canadian government has adopted the following rules governing the entry and appraisement of architects' plans:

Rates of duty on drawings, blueprints, and building plans, 20 per cent ad valorem. Specications, however, are free as "manuscript" when written or typewritten. Special plans of building or blueprints as substitutes therefor are to be valued for duty at charge usually made by architect for drawings without specifications. This charge may be fixed for duty purposes at 1 per cent of estimated cost of building to be erected. Detailed drawings or blueprints as substitutes therefor, if imported separately, are to be appraised at valuation of 1 per cent of estimated cost of such detail.

When building is estimated to cost less than $10,000, plans or blueprints thereof may be appraised at usual charges for furnishing same, according to the special circumstances in each case, irrespective of the preceding rule. Blueprints or copies of building plans may be admitted at cost of production when duty has been once paid on original or copy in Canada. Blueprints of cars and machinery, being copies of standard designs, may be valued for duty at 75 cents per pound.

A number of large buildings in this locality are designed by American architects, adds the consul, the same being true of other parts of Canada. No doubt they will be called upon for further plans, especially for large buildings of modern construction, and the order will therefore be of interest to them.

Stiffeners in Floor Beams.

In each stiffener the pitch of the rivets should not exceed that required in the adjacent portion of the flange. For practical considerations, however, it is desirable that when possible the pitch of rivets should be uniform in all stiffeners on the same beam.

If the beam is supported on its bottom flange it should have two pairs of stiffeners at the end, in order to transmit properly the shear upon the bearing. In case of heavy beams and plate girders, that portion of the web above the bearings should be also reinforced by additional plates.

Stiffeners are sometimes used without fillers, in which case the stiffener angles must be offset or crimped to fit over the legs of the flange angles.

It is not economy to do this, however, except in heavy beams. In light beams the cost of offsetting the angles will usually be greater than the cost of the material for fillers.

Metric Signs.

FRENCH RULES FOR ABBREVIATIONS.

The French minister of public instruction has decided that all teachers throughout France are in future to employ the following distinctive abbreviations for the various weights and measures: For denoting length—myriamètre, Mm; kilomètre, Km; hectomètre, Hm; décamètre, dam; mètre, m; décimètre; dm; centimètre, Cm, and millimètre, mm. For areas—hectare, ha; are, a, and centiare, ca or m^2. For measures of bulk (timber), décastère, das; stère, s or m^3, and décistère, ds. For measures of mass and weight—tonne, t; quintal métrique, q; kilogramme, kg; hectogramme, hg; décagramme, dag; gramme, g; décigramme, dg; centigramme, cg, and milligramme, mg. For measures of capacity—kilolitre, kl; hectolitre, hl; décalitre, dal; litre, l; décilitre, dl; centilitre, cl, and millilitre, ml. The use of the capital letters for the three largest denominations of length are intended to prevent confusion, and all the other abbreviations follow on uniform lines. The employment of full stops between the letters is officially abolished, and k. g. for kilogramme and m. m. for millimetre disappear.

Report of the Committee on Uniform Symbols for Wiring Plans.

(Appointed at the Fifth Annual Convention, held in Boston, July, 1905).

YOUR Committee, desiring to obtain an expression as to the advisability of establishing a uniform set of symbols and the best and most feasible methods of having the same universally used, addressed letters to the leading engineers, architects, universities, various departments of the government and the technical press. The replies to these letters were unanimously in favor of establishing uniform symbols, and the writers tendered their assistance and co-operation in the movement, and offered for the use of the Committee the symbols in use in their various offices.

The Committee was much gratified at the many expressions of approval of the plan and the appreciation of the effort of our organization in taking the initiative in this important work of standardization. The Committee made a careful study of all the letters and systems submitted to them, desiring to develop a set of symbols that would conform as closely as possible to the different ones now in use. They selected from the many valuable suggestions those which appeared the simplest in form and the easiest of execution, and added to them such others as seemed necessary to make the system complete, comprehensive and serviceable.

Each and every symbol has been given careful study, and while the Committee appreciates

STANDARD SYMBOLS FOR WIRING PLANS

AS ADOPTED AND RECOMMENDED BY

THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES.

COPIES MAY BE HAD ON APPLICATION TO THE SECRETARY, UTICA, N. Y.

Ceiling Outlet; Electric only. Numeral in center indicates number of standard 16 C. P. Incandescent Lamps.
Ceiling Outlet; Combination. $\frac{4}{2}$ indicates 4-16 C. P. Standard Incandescent Lamps and 2 Gas Burners.
Bracket Outlet; Electric only. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.
Bracket Outlet; Combination. $\frac{4}{2}$ indicates 4-16 C. P. Standard Incandescent Lamps and 2 Gas Burners.
Wall or Baseboard Receptacle Outlet. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.
Floor Outlet. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.
Outlet for Outdoor Standard or Pedestal; Electric only. Numeral indicates number of Stand. 16 C. P. Incan. Lamps.
Outlet for Outdoor Standard or Pedestal; Combination. $\frac{6}{6}$ indicates 6-16 C. P. Stand. Incan. Lamps; 6 Gas Burners.
Drop Cord Outlet.
One Light Outlet, for Lamp Receptacle.
Arc Lamp Outlet.
Special Outlet, for Lighting, Heating and Power Current, as described in Specifications.
Ceiling Fan Outlet.
S S. P. Switch Outlet.
S^2 D. P. Switch Outlet.
S^3 3-Way Switch Outlet.
S^4 4-Way Switch Outlet.
S^D Automatic Door Switch Outlet.
S^E Electrolier Switch Outlet.

Show as many Symbols as there are Switches. Or in case of a very large group of Switches, indicate number of Switches by a Roman numeral, thus; S^1 XII; meaning 12 Single Pole Switches.
Describe Type of Switch in Specifications, that is, Flush or Surface Push Button or Snap.

Meter Outlet.
Distribution Panel.
Junction or Pull Box.
Motor Outlet; Numeral in center indicates Horse Power.
Motor Control Outlet.
Transformer.
Main or Feeder run concealed under Floor.
Main or Feeder run concealed under Floor above.
Main or Feeder run exposed.
Branch Circuit run concealed under Floor.
Branch Circuit run concealed under Floor above.
Branch Circuit run exposed.
Pole Line
Riser.

Telephone Outlet; Private Service.
Telephone Outlet; Public Service.
Bell Outlet.
Buzzer Outlet.
Push Button Outlet; Numeral indicates number of Pushes.
Annunciator; Numeral indicates number of Points.
Speaking Tube.
Watchman Clock Outlet.
Watchman Station Outlet.
Master Time Clock Outlet.
Secondary Time Clock Outlet.
Door Opener.
Special Outlet; for Signal Systems, as described in Specifications.
Battery Outlet.

Suggestions in connection with Standard Symbols for Wiring Plans.

Indicate on plan, or describe in specifications, the height of all outlets located on side walls.

It is important that ample space be allowed for the installation of mains, feeders, branches and distribution panels.

It is desirable that a key to the symbols used accompany all plans.

If mains, feeders, branches and distribution panels are shown on the plans, it is desirable that they be designated by letters or numbers.

For the convenience of those making wiring plans the National Electrical Contractors' Association have provided and will furnish sets of marking stamps of these standard symbols. These will be found of great assistance to those preparing wiring plans and will be furnished for $ per set (cost of making) on application to the Secretary, Utica, N. Y.

Circuit for Clock, Telephone, Bell or other Service, run under Floor, concealed.
Kind of Service wanted ascertained by Symbol to which line connects.

Circuit for Clock, Telephone, Bell or other Service, run under Floor above concealed.
Kind of Service wanted ascertained by Symbol to which line connects.

NOTE—If other than Standard 16 C. P. Incandescent Lamps are desired, Specifications should describe Capacity of Lamp to be used.

that the subject gives ample opportunity for many individual ideas, they believe that considered as a whole the symbols submitted herewith will be found to cover all the conditions and requirements of complete wiring plans.

The Committee urges your full and careful consideration of the symbols and suggestions in connection with the same presented with this report, and if, in the opinion of this meeting, they are found to be suitable and acceptable that they will be adopted as the standard of this organization and recommended to all those connected with the art. In the judgment of the Committee it is most important that a set of uniform symbols be adopted by the National Electrical Contractors' Association at this meeting.

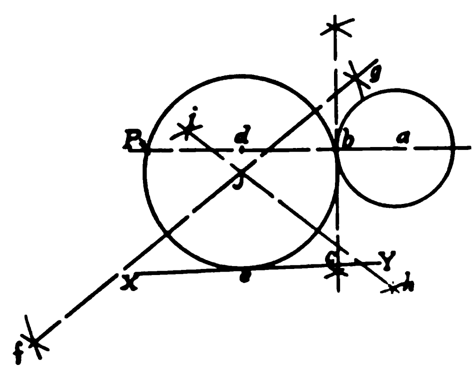
We recommend that a committee of three be appointed by the President to place the set of symbols prominently before those making wiring plans and obtain their universal use. We further recommend that this committee be instructed to select at least twenty members from different parts of the country to personally interview architects and engineers in their localities with a view of securing their use of these symbols. We urge that each and every member exert his best effort to obtain the universal use of these symbols to the end that they may become a recognized standard.

Respectfully submitted,
G. M. Sanborn,
E. S. Keefer,
J. K. How,
Committee on Uniform Symbols.

Question Box.

6 I want to draw an arc tangent, to a given circle, and to a straight line at a given point Is the enclosed solution correct? It seems to work out all right, but I cannot prove it.

Your solution is correct, and as it will probably be of interest to our readers, I will present it. R is the given circle, MN the given line and A the point on the line. To find O. Erect a perpendicular at A. With radius of R and A as a center draw an arc cutting the perpendicular drawn through A at A'. With radius equal to the distance from A to B and with A' as the center, draw an arc cutting R at B'. Produce B B' to its intersection with the perpendicular through A, thus giving the point O.



Proof:—$\triangle BB'A = \triangle B'AA'$ sides equal, therefore $\angle BB'A = \angle B'AA$; therefore $\angle OB'A = \angle OAB'$ supplements to equal angles, therefore $B'O = OA$.

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7. When asked what the three greatest powers were, I answered, "Incline, plane and pulley." Am I right?

There are many combinations of mechanism but there are only two primary elements, namely, the *lever* and the *inclined plane.* Power is transmitted by the lever through circular or angular action, that is, motion about an axis; while in the inclined plane power is transmitted by rectilinear action. The principle of the lever is the basis of the pulley, wheel and axle, etc.; that of the inclined plane is the basis of the wedge and the screw.

BOOKS AND CATALOGS.

Book Reviews.

Complete Examinations, Questions and answers for Marine and Stationary Engineers. By C. F. Swingle.

A complete Engine Operator's Catechism giving the latest and most approved answers to all leading questions which will be asked for the purpose of examining and determining the qualifications of applicants for licenses for engineers and for persons having charge of steam boilers as approved by all municipalities and government boards of Examining Engineers, both Stationary and Marine.

In all there are 800 questions and answers and many illustrations. The book is leather bound and of a size convenient for the pocket. Size 4½"x7". Price, $1.50. Frederick J. Drake & Co., 211 East Madison Street, Chicago, Ill.

Catalogs.

The handy office devices are described and illustrated in catalogue by The Baltimore Rubber Stamp Co., Box 895, Baltimore, Md.

Chain blocks, portable cranes, chain trolleys, hoisting crabs, etc., are shown in catalogue No. 37, by D. Round & Son, Cleveland, O.

Price list has been received from the American Carbon & Battery Company, East St. Louis, Ill. It is put together in loose leaf style.

The John M. Rogers Works, Gloucester City, New Jersey, recently sent out a folder on gauges, measuring machines and reference discs.

Pumping machinery, condensers, evaporators, and applied apparatus, etc., is described in a catalogue issued by M. T. Davidson, 43 Keap St., Brooklyn, N. Y.

The Monarch Electric Manufacturing Co., *Warren, Ohio,* have issued a folder on Monarch Lamps with a return postal in order to get a request for their proposition.

The Contractors Plant Manufacturing Co., of Buffalo, N. Y., have issued a 6¾ x 10½ catalogue in which they have described fully Steam, Electric, Horse and Hand Power machinery.

Richardson Scale Company, Park Row Bldg., New York City, are manufacturers of automatic weighing machinery, which is well described in a 6x9 catalogue now being sent out by them.

Bulletin "H" descriptive of the Cleveland Hand Power Crane, built by The Cleveland Crane & Car Co., Wickliffe, Ohio, has been issued and illustrates many uses to which these cranes can be placed.

The subject of locomotive cranes is well treated in a catalogue of the Wellman-Seaver-Morgan Co., Cleveland, Ohio. This subject is also described in this issue in which some of these cranes are illustrated.

Drew Machinery Agency, Manchester, N. H., have issued list "K" of second hand horizontal, portable and vertical steam, gas and gasoline engines and boilers. It contains a large number of other machines besides what is here noted.

The Dean Boiler Tube Cleaner is nicely described in a little book issued by the Wm. B. Pierce Co., Buffalo, N. Y. Attached to this book is a return postal card, upon receipt of which they will send a Dean Boiler Tube Cleaner on trial.

John A. Roebling's Sons Co., Trenton, N. J., have a 6x9 catalogue of 160 pages, illustrative and descriptive of wire rope and fittings and also describes the use of the wire rope and in a great many ways in which it is used and is well illustrated.

The well-known firm of the Atlas Engine Works, Indianapolis, Ind., have put on the market a Medium Speed Automatic Four-valve Engine of high economy. This is described and illustrated in an 8 x 10 catalogue issued by them and includes diagrams for the setting of these engines.

The Taylor Engineering Co., of New York City, building stamp milling machinery, illustrate their work in a neat catalogue in which they include mortars, ore feeders, rock and ore crushers, amalgamating pans, settlers, agitators, clean-up pans and barrels, amalgam safes, retorts and accessories.

Mr. Hugh R. Blethen, Park Row Bldg., New York City, sole selling agent of the Reading Crane & Hoist Works machinery which is described in catalogue No. 40. The works are located at Reading, Pa. They manufacture hand traveling cranes and trolleys.

The Franklin Portable Crane & Hoist Company, Franklin, Pa., have issued booklet on the Franklin portable crane and hoist. They are used in factories, shops and other places where it is necessary to lift heavy bodies or to transfer them from place to place with the least expenditure of time and labor.

Ernst Weiner, 68 Broadway, N. Y., issued a catalogue on Railway Materials, for all industries, such as Portable, Industrial and Permanent Tracks, Industrial Track Layouts, etc., switches, frogs and crossings, turntables and transfer cars, and steel and wooden cars of every description for all industrial purposes.

We have received from The Minster Machine Co., of Minster, O., a catalogue on machinery for the transmission of power in which they describe Friction Clutch Pulleys, Friction Cutoff Couplings, Cast Iron Pulleys, Shaftings, Hangers, Couplings, Pillow Blocks, Belt Tighteners, Oil Well Pumping Powers, Rig Irons.

In their catalogue No. 28 The Goodwin & Kintz Co., of Winsted, Conn., illustrate and describe fully a very fine line of Gas and Electric Portables. The Art Glass Shades shown in this catalogue are largely exclusive designs and in most instances are gotten up especially to harmonize with the stands with which they are illustrated.

The Lidgerwood Manufacturing Co., New York City, have their literature divided under the heads of Cable, Ways, Rapid unloaders, Logging by steam, Derricks and Hoisting Engines, which is produced in two sizes, namely 6 x 9 and 9 x 12. They have issued a second edition of their booklet on Contractor's Methods employed on the great Chicago Drainage Canal. These catalogues are all finely illustrated and very descriptive of the machinery made by this firm.

The Baldwin Locomotive Works, of Philadelphia, Pa., have given a record of their recent construction of seven booklets. Booklet No. 52 described forged and rolled steel wheels; No. 53 gives notes on the Principles and Performances of the Balanced Compound Locomotive; No. 54 pertains to a great variety of locomotives, of different guages, etc.; No. 55 describes fully the Walschaerts Valve Gear; No. 56 gives a description of the Atchison, Topeka & Santa Fe Railway System; No. 57 gives the Common Standard Locomotives of the Associated Line and No. 58 gives the Ceremonies at the Unveiling of the Statue of Matthias W. Baldwin.

No finer catalogue of machinery has been received for some time than that issued by The Link Belt Engineering Company, of Philadelphia. It is entitled "Modern Methods applied to the Lifting and Conveying of Materials and Transmission of Power." It is well bound in cloth, containing 332 pages, size 6 x 9 as recommended by the American Society of Mechanical Engineers. It is more of a reference book than a catalogue as the illustrative and descriptive matter is arranged along in a very much more progressive manner than the average booklet or catalogue. All the subjects of brake chains, wheels, troughs, hopper, gates, bearings and other accessories are fairly described.

EDITORIAL COMMENT.

The new style of spelling is being used by the *Engineer*, published at Chicago, and among the words used are "prest" for pressed and "finisht" for finished.

The sound of "T" is more strong in the ending of the former than the latter word, yet the "ed" sound is good enough for us.

Since the time when President Roosevelt was credited with the statement that such words should be spelled a certain way, the newspapers of the country have commented on it extensively. There was no intention to make it compulsory but the question arose, would it be accepted in civil service examinations.

It was decided to accept either the old or the new but where one is not sure of the new, he should use the old for an error in either case would reduce his percentage just the same.

It will be noted that mention is made in these pages of Civil Service examinations held at different times but the dates are often very close to the receipt of the magazine in the hands of our readers.

We try to make the announcements with as great a time limit to them as possible so that our readers may take up the matter if they so desire.

The Civil Service Commission, Washington, D. C., will give all desired information and any one wishing to get into government work should write there so as to have all time possible.

The notices that come to this office include the conditions and places where examinations are to be held and are suitable to a large number of vocations.

Information in advance of the issue of the magazine will be given from this office if so desired.

"Five thousand trade unionists in Chicago have purchased certificates from the Union Burial Association, providing for strictly union burial for themselves or their families; within sixty days as many more members of labor organizations will have made similar arrangements. In order to complete the plan of having trade union principles adhered to at the obsequies of unionists or of members of their families, it is now proposed that a union cemetery be secured."

This may be all right, we usually do not care where we are buried. We wonder what will be the next move.

Owing to the failure of many young men to learn trades, either from the restrictions of trade unionism or other causes, the builders' exchange of Cleveland has decided to inaugurate manual training classes, at which the scope of work begun in the public manual training schools shall be extended to afford the students an opportunity to acquire proficiency in the building trades.

A special committee of the organization has been appointed to take up the matter, canvass the situation, and decide on a plan of action. The Mason Contracting Company conducted a class in bricklaying last winter, and the eagerness with which the young men pursued the course and the rapidity with which they became skilled workmen has induced the exchange to equip a school where others of the building trades can be acquired by graduates of the ward schools.

The builders claim that a boy with a public school education has only to learn to handle the tools of the trade he seeks to master as he has been taught in the school the rudiments or drawing and how to calculate dimensions used in building that under the old method of apprenticeship were taught by arbitrary rules of the craft.

The members of the exchange who form the committee to plan the new method of teaching the trade are: C. H. Fath, William Flood, James Young, E. H. Towson and John Lease.

VIEWS TAKEN AT THE STREET RAILWAY CONVENTION AT COLUMBUS, OHIO, OCTOBER 15-19, 1906.

Browning's

Industrial Magazine

VOL. 5 NOVEMBER, 1906 NO. 11

Automatic Safety Devices for Steam Engines, Turbines and Motors.

BY CHARLES M. HEMINWAY.

THE increasing use of automatic appliances is a noteworthy feature of the tendency in engineering development. In the electrical industries automatic appliances are largely used, and the results have been so good that we find the peculiar flexibility of electrical systems leading to their use for automatic apparatus in other lines of work.

There is probably not an electrical system today, either for transportation or power purposes, for lighting, telephone, or any of the other various applications of electricity, in which some automatic devices are not used. These appliances may take the form of regulators or governors for controlling the performance of a machine. In railway work they are extensively used for signaling.

Though the application of automatic appliances is varied and extensive, it is the purpose of this paper to touch upon one branch only; that is, to prevent damage that might be caused by unusual or unexpected conditions. In the equipment and operation of power plants, mills and factories the two factors that are first given consideration are efficiency and economy. The factor of safety also receives attention and is becoming more generally recognized as a necessity, for without it the two former are of little avail, yet in the particular branch to which I wish to direct your attention it has not been so generally introduced as in some others.

Automatic Stops bear the same relation to steam engines and turbines that safety-valves do to boilers, or circuit breakers to dynamos. It is probably that the universal adoption of circuit-breakers closely followed an unusually large number of accidents; similarly, the alarming increase in the number of runaway engines and resultant flywheel wrecks will doubtless hasten the general use of safety devices for engines and turbines. There is a general impression among engine owners that the governor on the engine is a safety device, and is capable of providing for all emergencies; this is a fallacy, as statistics show that about 200 reciprocating engines and several turbines and synchronous converters have run away in the past twenty months and all had governors.

The governor is designed to keep the speed of an engine constant under variations of load, but as most governors are arranged to operate by centrifugal force they cannot act instantly, as when the load goes off suddenly; it is for this reason that there is real need for a safety device entirely apart from the governor that will act quickly in case of emergency.

Fig. 1—Corliss Type of the Monarch Engine Stop and Speed Limit System.

Fig. 2—The Monarch Automatic Speed Limit.

Some of the causes of recent flywheel accidents are: breaking of main belt; loose governor pulley; reversal of dynamo; sticking governor; but chiefly the breaking or slipping of a governor belt and the sudden relief of the load.

Some plants now carry flywheel insurance, which includes periodical inspections. This furnishes monetary protection, but does not insure safety; for in spite of the inspections, flywheel accidents continue to occur. It will be readily seen that while inspections may detect a weakness in some part of the engine equipment, or the inefficiency of an engineer, many things may happen between the inspections. While the insurance pays the property damages and personal injuries, it does not make good the losses from non-production pending repairs to the plant, nor the wage-loss of the employes. Obviously, then, the remedy lies in the providing of such means as will *prevent* accidents.

There is still another use for the same device; namely, to shut down the engine from a distant part of the plant by pressing a switch. When an employe is caught in the machinery, when the belting breaks, when the

Fig. 3—The Monarch Type of the Monarch Engine Stop and Speed Limit System.

shafting or the machinery is out of order, when a cylinder-head blows out —in all cases when it would be impossible to reach the throttle promptly, the automatic stop is invaluable.

Engine-Stops are of varied design and are applied in many different ways. Most of them are designed merely to stop the engine mechanically in case of over-speed. There is a growing tendency toward the use of electric current to trip the engine-stops, thus allowing them to be operated from any number of points.

One stop is designed to be attached to the governor column, and, upon being tripped electrically, opens a steam-valve, allowing steam to enter a small cylinder against a piston, which raises the governor balls to their maximum position, thereby cutting off the supply of steam to the cylinder. This is a reliable stop and in connection with a speed-limit

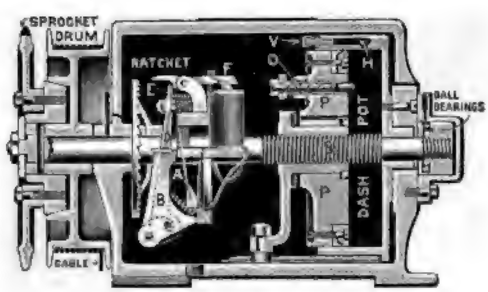


Fig. 4—Vertical Section of Monarch Type of Stop.

device is very effective. It is called the Corliss type of the Monarch Engine Stop System. See Fig. 1.

The speed limit consists of a centrifugal device connected to the engine shaft by a chain-drive; it is in circuit with the engine-stop and can be set at any predetermined speed; when this speed is reached, electric contact is made by tripping the engine stop. Fig. 2.

Other forms are applied to special valves which must be placed in the steam line and operated as an auxiliary to the main throttle valve. The valve in these forms is usually closed by steam pressure, the steam being admitted to some small cylinder and moving a piston in closing. These forms have many points in their favor but care must be taken to keep them in order, and the expense of inserting a special valve in a steam line already erected is rather great.

Another type of engine-stop operates directly upon the throttle-valve, and can be easily applied to any engine without interfering with its regular work. This is called the Monarch type of the Monarch Engine Stop

and Speed Limit System. Fig. 3. It is bolted to the engine frame at any convenient place and is attached to the valve-stem by means of a sprocket wheel and chain. As the valve is opened, a cable, to one end of which is attached a weight, is wound on a drum on the stop and is held by a pawl which engages in a ratchet wheel. When the Stop is tripped electrically, the weight is released, revolving the sprocket wheel and thus closing the valve, a dash-pot in the stop forming a cushion to prevent jamming the valve. This, in connection with the speed limit, forms a very satisfactory device; and as gravity is depended upon for doing the work, there is nothing that is likely to fail in operating.

Fig. No. 3 shows the Monarch Engine Stop with the cylindrical iron

Fig. 5.
Type "F" Test Board installed with the Monarch Engine Stop and Speed Limit System

case half opened on its hinges; thus permitting easy examination. When in use, this is kept locked so that nothing can injure the interior mechanism in any way. Passing through the shell or case turning on ball bearings is a steel shaft, 1½" in dameter, on the outer end of which is a fixed drum, to which is belted a sprocket wheel.

In Fig. 4 will be seen a wire cable passing around this drum which is attached to a weight serving as power to operate the stop.

Inside the case and fastened to the shaft is a ratchet wheel engaged by a pawl (B), which prevents the weight from turning the shaft in the direction that closes the valve. This pawl is held in engagement with the ratchet by vertical lever (D), which is held in position by the left end of the armature lever (F). The magnets are placed in circuit with an electric current, and when the circuit is closed, the armature end of the lever (F) is pulled down, releasing the upper end of the vertical lever

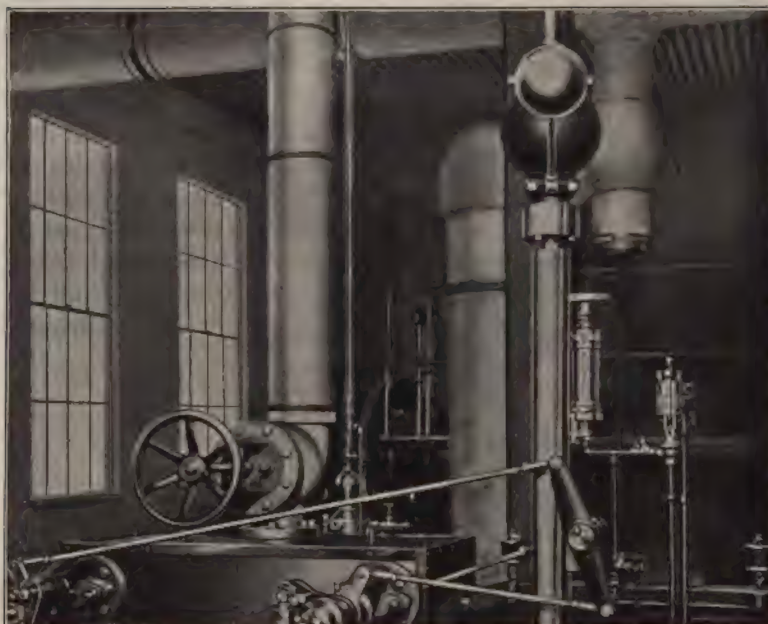


Fig. 6—Application of the Corliss type of Engine Stop to the governor of a Corliss Engine.

(D) which also serves as a hammer, striking a lug on the pawl (B) throwing it out of engagement with the ratchet, thus allowing the shaft of the stop to revolve and close the valve by means of sprocket chain attached to the sprocket wheel of the stop, engaging a similar sprocket wheel attached to the throttle valve stem, the weight, as before mentioned, furnishing the power.

At the opposite or right end of the stop is a dash-pot, as illustrated in Fig. 4, which consists of a cylinder into which the piston (P) fits closely. On this end of the shaft is cut a square threaded screw (S), passing through a nut fastened in the centre of piston (P), so that as the shaft revolves by means of this screw the piston is carried into the cylinder and the air behind its inner face is compressed, forming a perfect cushion. The speed at which the stop acts may be accurately adjusted by turning the by-pass valve (V) that governs the amount of air that is forced through the air passage (H) as the piston moves in. Below this by-pass valve (V) and in piston (P) is located the releasing valve (O); this releasing valve (O), which is opened by contact against the bottom of the dash-pot, is adjustable. After the piston has cushioned and the throttle valve of the engine is near its seat, the compressed air in chamber (H)

escapes through this releasing valve (O), allowing the throttle valve to take its seat softly, but yet with sufficient force to close it tightly.

Another engine stop also operating on this throttle and connected to it with a sprocket wheel and chain, similar to the one just described, is operated by an electric motor, ¼ H. P. or ½ H. P. This is more expensive on account of the motor and the necessary generating apparatus. The current can be taken from bus-bars, but in order to insure reliability it is advisable to have the engine furnish its own current. This kind of stop is particularly desirable on units having 12-in. valves, or larger.

In order to insure protection for all contingencies, an automatic vacuum breaker is wired in the circuit with any of the engine stops where condensing engines are equipped with this safety device, so that if the engine should be shut down automatically, the automatic vacuum breaker will operate simultaneously with the engine stop, opening the exhaust to the atmosphere.

Another provision for safety has been provided in an automatic circuit breaker trip which also is wired in the circuit with the engine stop. In plants where engines operate generators in multiple, the closing of the circuit, either automatically by the speed limit, or from any of the push switches in the system, operates not only the engine stop, but also the circuit breaker trip, cutting out the generator to prevent it from running as a motor.

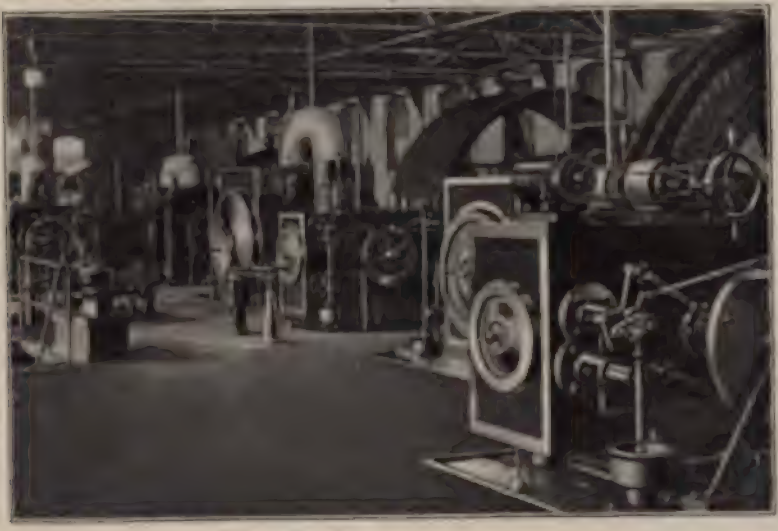


Fig. 7—Application of the Monarch Type of Engine Stop to a Horizontal Valve Stem on Cross Compound Engine at the Narragansett Electric Lighting Co., Providence, R. I. This is one of the eleven Monarch equipments in this plant.

Where electricity is used in tripping a stop it is desirable to have some means of testing the circuits and strength of the batteries. A very satisfactory system is in use for this purpose; a small slate test board having upon it a switch for tripping the stop, a buzzer or a lamp, and two small key-switches for testing the circuits. The buzzer is of high resistance and if the batteries are getting weak an intermittent response of

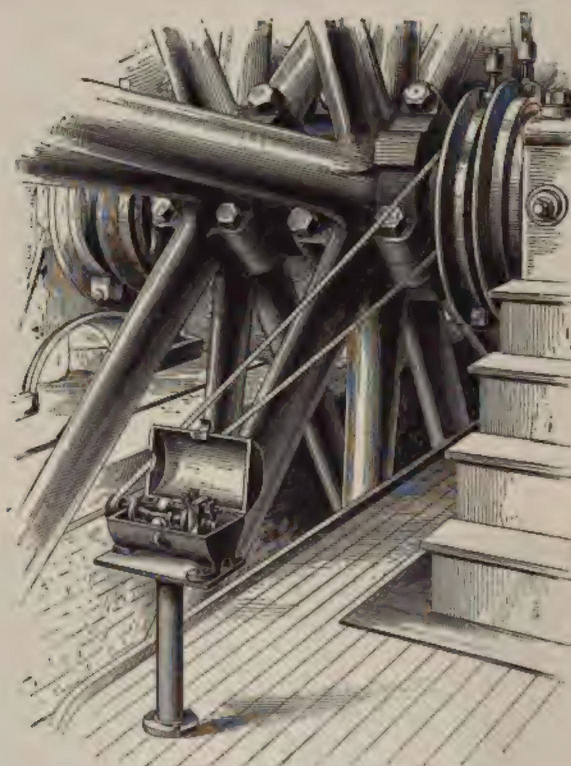


Fig. 8.—Application of the Monarch Automatic Speed Limit to the Main Shaft of an Engine

the buzzer will indicate this, and yet current for at least twenty-four hours is still available to use the stop, allowing sufficient time for recharging the batteries.

A failure of the buzzer to respond to the pressure of the test switch indicates a break in the wiring, but pending repairs to the wires it is possible to shut down the engine either automatically by the speed limit or from any of the push switches. This is accomplished by throwing the wires from multiple into series for a test, so that though the indication of a break in the circuit is instantly detected, the engine stop system is still

in commission. This is one of the strongest points in favor of engine stops, as it insures reliability; the safety device cannot be crippled by weak batteries or broken wires, but is always ready for emergencies.

There is also another test board in use, substantially the same as the one just described, but with the addition of a solenoid switch Fig. 5. This is designed to use high tension current to operate the engine stop with battery in reserve. It can be used on any voltage from 110 to 550. The voltage is cut down by means of resistance coils on the test board, and the current going through the solenoid holds the armature against the magnets operated on the generator.

If the generator furnishing this source of current is shut down or a fuse blows, the armature falls by gravity to the battery terminal and the engine stop system is then operated from the battery circuit until the direct circuit is again in service. This system adds an additional safeguard from the fact that there are two sources from which to operate the engine stop. It is particularly desirable in factories, where the generator current is not on during the day. It lengthens the life of the batteries, as they will be used only a portion of the time.

While this paper is confined more particularly to the application of automatic safety devices to engines, the same appliance in modified form is working successfully on steam turbines, synchronous converters, motors, gas and oil engines and water wheels.

It has frequently been said that automatic safety stops are an expense that do not add to the efficiency or economy in the operation of the plant. A few facts bearing on this point will serve to prove the contrary. First, certain types of stops are recognized by the liability insurance companies, and a reduced rate on employers' liability insurance is allowed; secondly, where automatic safety stops are used flywheel insurance can be dispensed with. Here are economies that begin to accrue the moment the stop is installed.

Admitting that no plant is entirely safe from accident; when the emergency does occur the small amount invested in stops will save fron ten to twenty times their cost in damages prevented. Records show that large property losses have been averted and many lives saved by their prompt and efficient operation.

Telpherage, or Man Trolley System.

TELPHERAGE is the electrically operated method of transporting materials, boxed, barreled or loose, solids or liquid, and derives its name from its distinctive adaptability to long distance carrying. It may be popularly explained as a trolley system of conveying.

Economy of operation, essential to all conveying mediums is particularly a feature of telpherage, the loading, hoisting, conveying and unloading all being under the control of the operator. The interference of driveways, rivers, railroads, streets and severe and local conditions is overcome.

This system is the outcome of the hand trolleys we see so often in our shops and factories and has developed into wonderful propositions both as to track and trolley design.

Telpher system at Lowell Gas Light Co., Lowell, Mass. Built by Dodge Coal Storage Co., N. Y.

These systems are fast becoming a most potent factor in the expense reduction incident to movement of materials in and from industrial establishments. The design of supports calls for much variation and the engineer must resort to some ingenuity to accomplish the results.

Telpherage systems are generally built of one track, but this may not be said as characteristic of them.

The use of the trolley may be to handle cars, buckets or hoist weights independent of either. Some methods for conveying materials would

General View of the Telpher Line at the Lamokin (Chester) Pa., Wharf of the Philadelphia Quartz Company.

answer as well as the trolley, but there are cases where it is no doubt the best. An instance of this kind is shown at the plant of the Lowell Gas Light Co., of Lowell, Mass. The order of the work is as follows:

The hot coke is conveyed from the retorts and discharged into a pit outside the retort house; the telpher with its self-filling bucket takes the quenched coke to the screening house where it is crushed and sized (and distributed to bins) for domestic sale; the breeze from the sized coke is telphered to a storage pocket for future use. The water gas retorts and the boilers are charged with coke delivered by the telpher from storage;

Five Ton Bucket-Handling Trolley for Conveying Coal and Ashes at Plant of Hudson Portland Cement Co., Hudson, N. Y.

the same source of supply being drawn upon for crushing as demands determine.

Then—showing the particular economy of telpherage—the ashes are conveyed by this same machine to cars or other determined location for eventual disposal.

What this installation accomplishes can be best realized when you know the speed of hoisting the loaded bucket is nearly 100 feet a minute; and the telpheraging, or travel proceeds at the rate of 1,000 feet a minute; the round trip from retort house to storage pile occupies but a minute and a half, and a ton of coke or a ton-and-a-half of ashes can be handled each trip.

A man trolley or telpherage system was installed at the Hudson Portland Cement Co. to carry coal from boat to storage piles. The track is constructed of I beams, capable of sustaining a weight of 50,000 pounds at any point and having a turntable for reversing the trolley.

The bucket has a capacity of 4 yards or 3 tons with a lift of 65 feet and speed of 100 feet per minute and travel of 700 feet per minute.

The total length of track is 800 feet and the trolleys have a gauge of 36 inches.

Track of Trolley System at Hudson Portland Cement Co., Hudson, N. Y. Built by the Browning Engineering Company, Cleveland, Ohio.

Telpherage system had been established for contractors' use, in one instance, for tunnel and terminal excavation work of the Pennsylvania Ry., New York City, for the United Engineering & Contracting Co. The hoisting capacity of these machines was 5-tons at 200 feet a minute. The telpherages were operated at fully 24 hours daily and handled up to 6 or 8 tons. The hoisting drums were driven by double cone friction clutches,

Telpher System for Contractors' Use. Installed by Dodge Coal Storage Co., N. Y.

so the empty tubs could be lowered at great speed. The depth of the shaft was 125 feet.

The telphers were used to handle the material for the construction work too.

In many cases the tracks are very low, especially in buildings used for storage purposes, but the principle is the same. In these cases the hoisting is often done by hand but because of the high speed at which they operate, rendering heavy and long distance hauls economical. Electric hoists are important adjuncts of telpherage. While the standard hoisting speed is from 60 to 120 feet per minute, and the conveying speed from 600 to 1,000 ft. per minute, higher or lower speeds are possible and are governed by the nature and demands of the work.

In a few instances a cable telpher line have been built, the cable extending over the storage piles and the telpher supported by frame work when over the cars at the hoist end.

Telpher systems will work in an incline, one being installed at Newport, Ky., where a 5 per cent grade is encountered and there are a great number of instances where the tracks contain curves.

So many applications of this system are in use that it would require an immense amount of space to enumerate them all, but suffice it to say that there will be illustrations of these frequently, for it is a subject that should require considerable attention.

Automatic telpher machines have been built where the traveling, hoisting and reversing is largely independent of the operator.

In an installation for conveying ashes from boiler house to pocket for delivery to cars, the bucket is filled by the fireman who throws a switch, the load is elevated at a speed of 60 feet per minute, conveyed at a speed of 200 ft. per minute, automatically dumped, returned and lowered, ready for another load.

No two plants are alike, neither are conditions, so to be safe in design and construction of unusual conveying machinery necessitates experience, constant vigilance and courageous initiative.

Jib Crane Design.

W. P. ROBINSON.

IN designing a jib crane there will always be a certain set of local conditions for each case which will fix the height of mast, extreme radius of load, the load to be lifted, and whether it is to be operated by power or by hand. The latter having some bearing on the factor of safety which must be greater in the case of a power crane because of the more jerky stopping and starting incident to the use of power. A factor of safety of four will generally suffice for hand power cranes, while for power cranes it should be five or six, or possibly even greater in such a case as a pipe

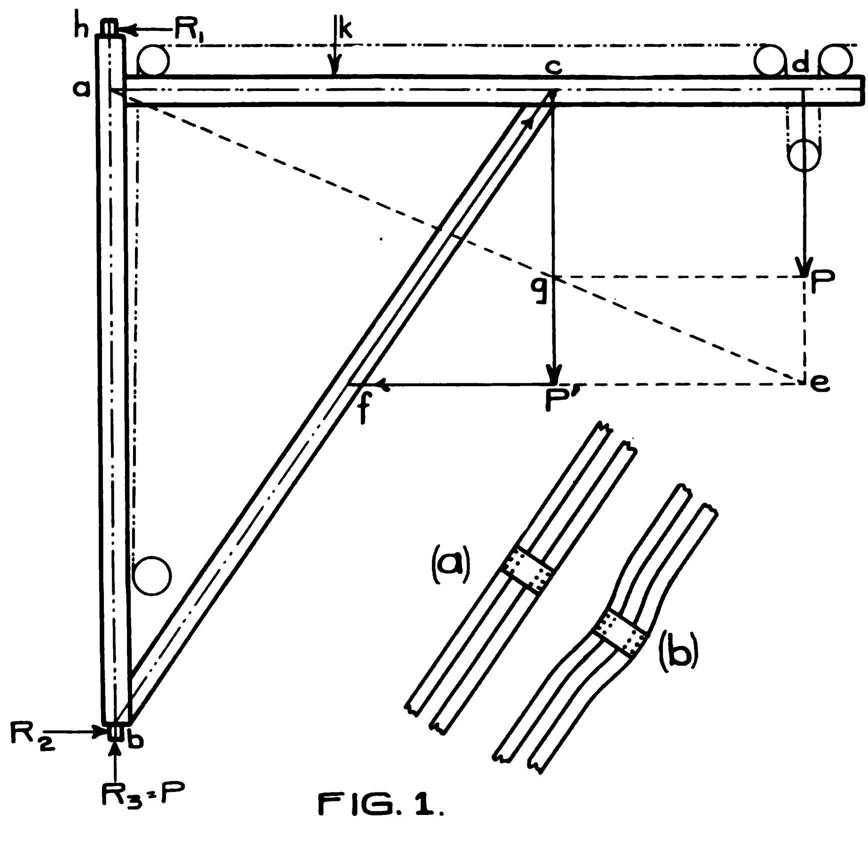


FIG. 1.

foundry crane, which is about the toughest proposition in the jib crane line. Then, also, local conditions may prohibit the use of a brace as shown in fig. 1, in which case the design must be like fig. 3, 4, or 5. Or the desired radius of operation may be so great that it becomes advisable to brace the jib in more than one place, making the design like fig. 2.

Jib cranes shown in fig. 1 and fig. 2 are usually of double I beam or double channel construction, according to the capacity. The sections used must be chosen with regard to strength, appearance, and economy of material. Figs. 3 and 4 are usually made with double channel mast and jib, and braces of angles or rods. Fig. 5 is an expensive cantilever construction, built up of plates and angles. The carriage, or trolley carrying the load, can be made to travel on angles between the plates forming the jib, thus makng a very neat appearing crane. It is a design not much used, however, on account of its expensive construction. There are many modifications of the types shown possible, *e. g.*, the pillar, or self-supporting jib crane, which is in a class by itself, but these are the types in most general use.

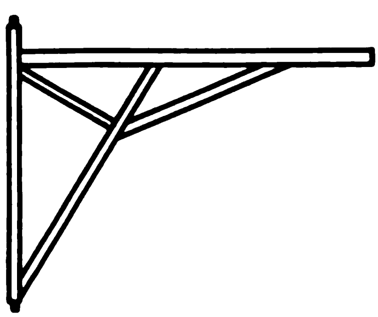


FIG. 2.

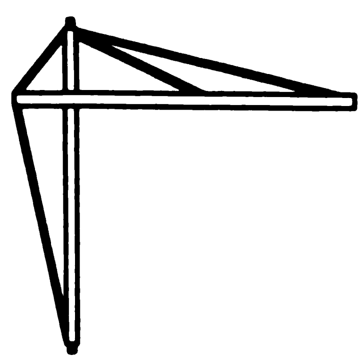


FIG. 3.

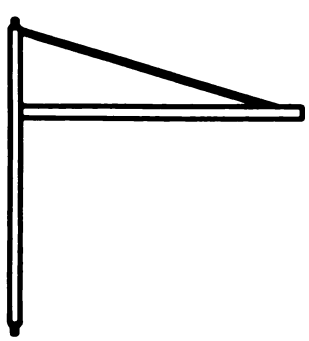


FIG. 4.

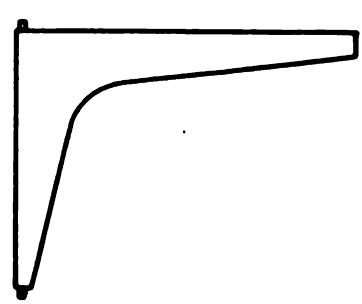


FIG. 5.

Consider the design of the simplest form of jib crane, shown in fig. 1. After the three members have been laid out approximately, with due regard to symmetry and local conditions, proceed to find the stresses as follows. The sizes of beams which will give the required factor of safety can then be selected:

Let P be the total load moving along the jib, i. e., the sum of the load on the hook and weight of the carriage and block. The greatest stresses in the mast will evidently occur when the load is at d. Draw a vertical line from d and lay off to some convenient scale dP equal to P. Draw Pg parallel to da until it intersects a vertical from c in **g**. Draw a g e through a and g, and eP' parallel to Pg. cP' represents the force at c equivalent to P at d. Or the value of P' can be found from the equation

$$P' = \frac{P x ad}{ac}. \quad (1)$$

Extend eP' to f and $P'f$ is the amount of tension in ac to scale. The amount of compression in bc is equal to fc. fP' is also the exterior horizontal reactions at R_1 and R_2. The maximum bending moment (B.M.) in the mast is therefore $fP' \times ah$ (2).

The mast is usually composed of two beams and each beam must stand half this B.M. In addition to the B.M. in the mast produced by the tension in ad, there is also a tension, when the load is at d, caused by the tendency of ad to rotate clockwise, and the vertical component of the thrust in bc (acting in ab) to keep it from rotating. This tension is equal to P' — P. But, on the other hand, there must be a compression, eccentric by the way, in the mast if the hoist rope runs from a winch at the base of the mast to the top, as shown in fig. 1. The value of this is usually $\frac{P}{2}$. It is evident then that these two opposing forces approximately balance each other and can be neglected.

The maximum B.M. due to the load, called the live B.M., in the jib is equal to

$$P \times cd \quad (3)$$

when the load is at the end, and

$$\frac{P \times ac}{4} \quad (4)$$

when the load is between a and c.

In order to find the B.M. due to the weight of beams in jib, called the dead B.M., either assume the size tentatively, or select a size a little larger than necessary for the B.M. as given by (3) or (4). Then dead B.M. =

$\frac{w\,cd^2}{2}$ (5) or $= \frac{w\,ac^2}{8}$ (6).

w is the weight of beams per foot, all dimensions being in feet. Adding (3) and (5) will give the total B.M. when load is at end. Adding (4) and (6) will give the total B.M. when load is at K. Try to have these two results as nearly equal as possible. Select beams from the hand book to resist the maximum B.M., remembering always that these members, discussed here as single are usually double, so that each beam takes half the B.M.

Next consider the compression member *bc*. The amount of compression is *fc* to scale. If the two beams composing *bc* are not tied together between c and b, each must be figured as a column with pin and square ends; i. e., the length in feet must be divided by the least radius of gyration of an assumed section and the ultimate strength per sq. inch corresponding to this value picked from the hand book column tables. This multiplied by the area of section and divided by the factor of safety will give the safe working stress for the strut, which must be equal to or greater than the stress *fc*. It may be necessary for one who is not experienced to try two or three sizes of beams before hitting on the right one. If the beams be tiı pəogether with narrow plates as in fig. 1 (a), it is well to still take the entire length and not simply the length above the plate in finding $\frac{\text{"l"}}{\text{"r"}}$, for the reason that if each beam decides to buckle the same way as in fig. 1 (b), the only resistance would be the plate rivets in shear and if the rivets are close together this resistance amounts to little. It can be seen that if any bracing be used it should be wide plates or latticing. It is also obvious that the minimum radius of operation also governs the location of this bracing, since the hook must travel between the two beams.

New German Electric Blast Furnace Hoist.

BY FRANK C. PERKINS.

ELECTRIC power is now being so extensively used in iron and steel works in Germany and other European countries, as well as in America, that it is fast replacing steam engines and other forms of power for operating nearly all of the labor-saving devices utilized at these plants. Electric current is generated by blast furnace gases in high power internal combustion engines, and utilized for operating the live rolls, the shears, punches, straightening machines and other devices in the iron and steel plants,. in some instances even replacing the steam engine for operating the rolling mills as at the plant of the Gutehoffnungshutte at Oberhausen, Germany, where 1,500 h. p. motors are employed for this purpose running two roll high mills.

Electric power is also extensively used for operating the overhead traveling cranes, the bridge cranes for transporting the ore, coke, and lime, and the hoists for raising this material to the top of the blast furnace.

A new German electrically operated hoist for conveying the coal, coke and lime to the mouth of the blast furnace is shown in the accom-

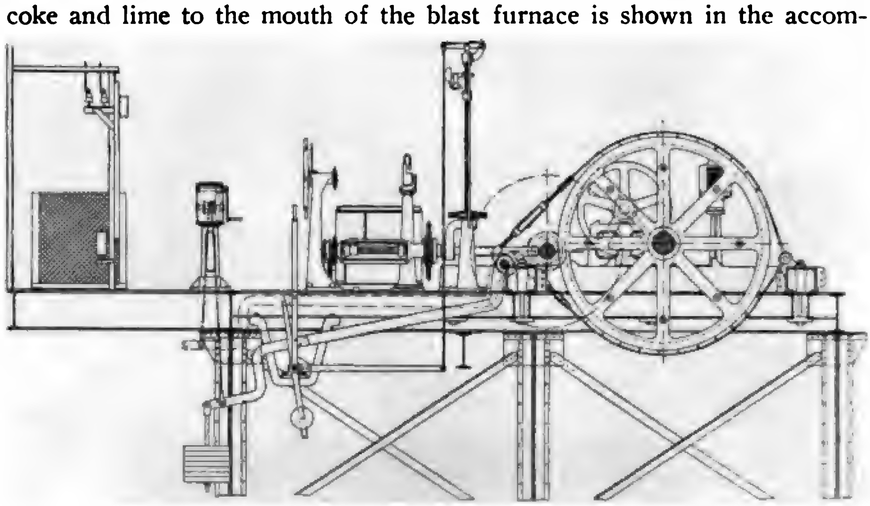


Fig. 1.—Switchboard Controller and Brake Mechanism Blast Furnace Hoist.

panying illustration Fig. 1, two electric motors being employed, and two winding drums operating cars on two sets of tracks, as shown in the accompanying drawing Fig. 2 of the blast furnace and electric hoisting apparatus. The electric motor and winding drums being mounted in a small building near the base of the blast furnace. The accompanying diagram Fig. 3 shows the electrically operated drums, the controlling mechanism, switchboard and braking devices, while the diagrams Fig. 4

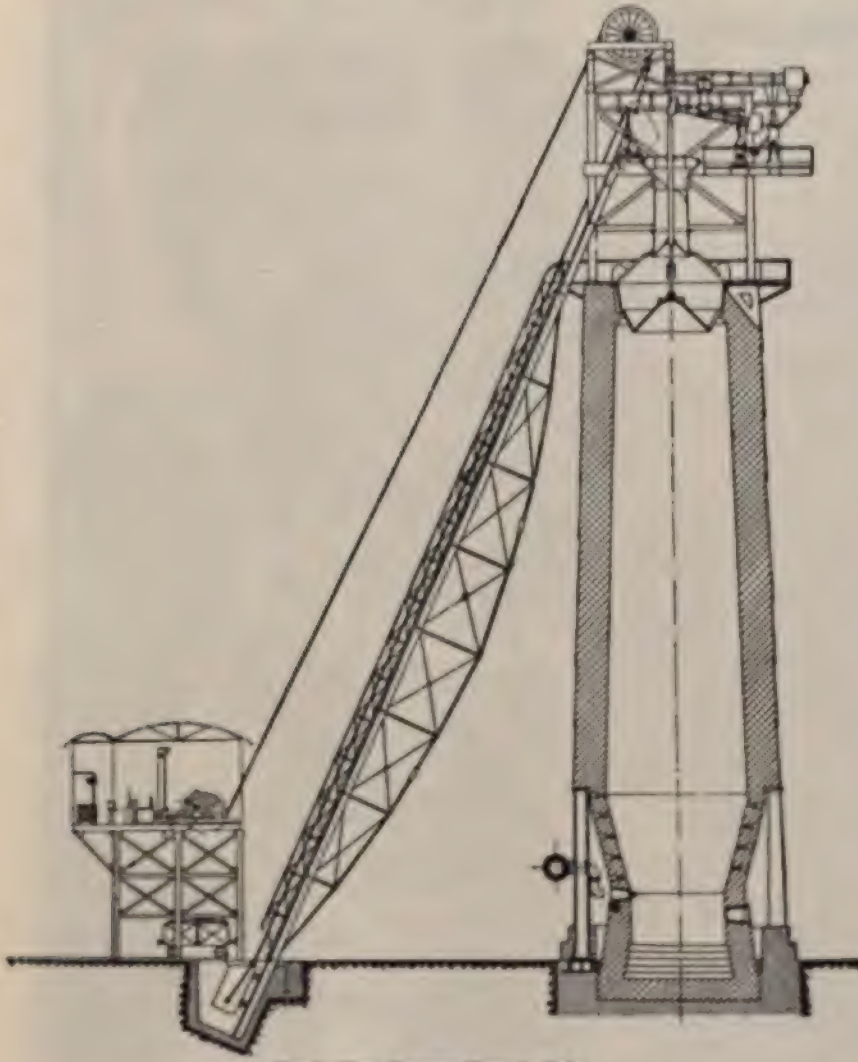


Fig. 2—Blast Furnace Electric Hoist.

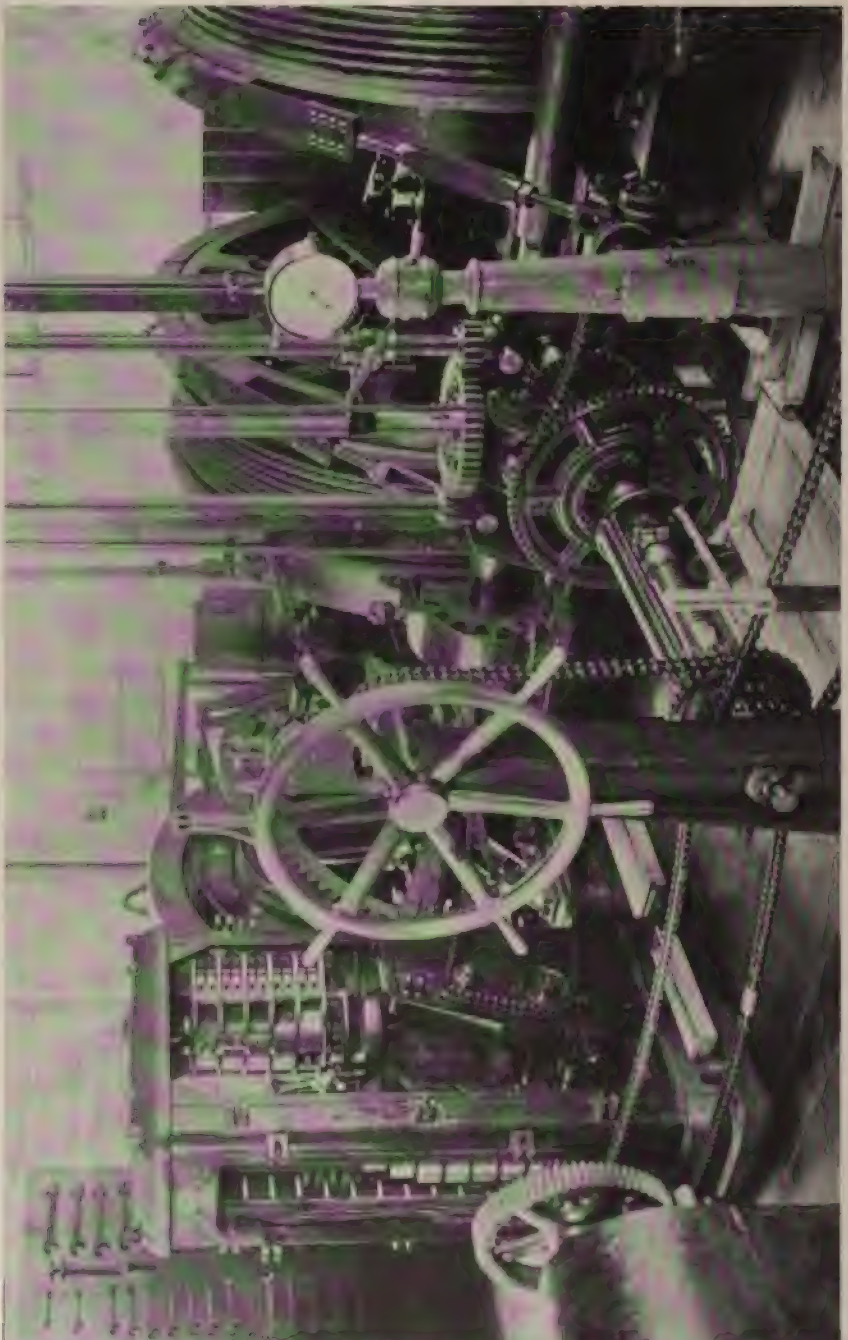


Fig. 3—New German Electric Blast Furnace Hoist.

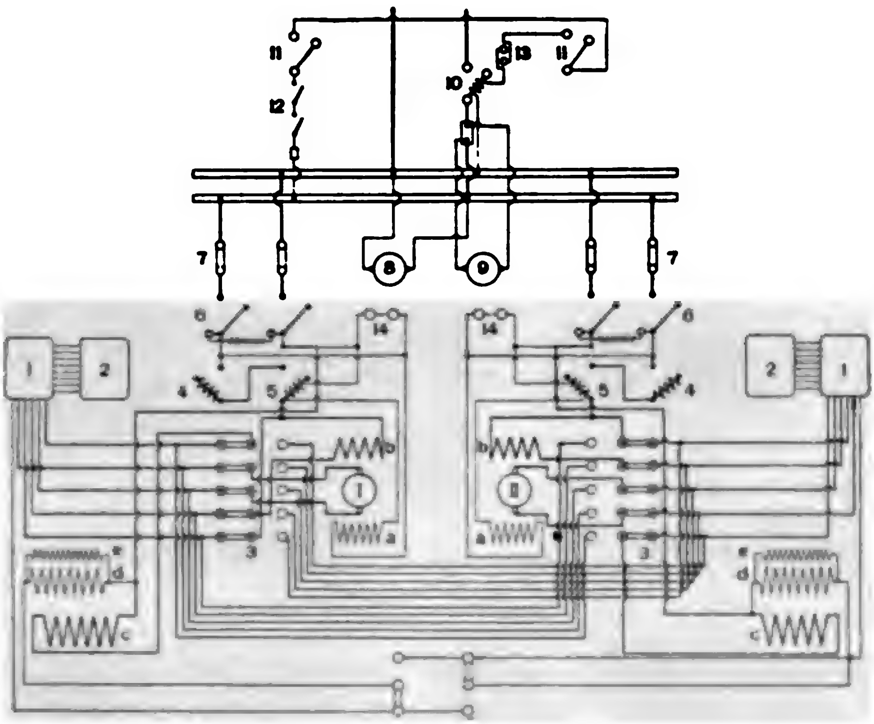


Fig. 4 -Electrical Connections Blast Furnace Hoist

shows the electrical connections of the motors, and the self-starting devices noted in accompanying illustrations Figs. 5 and 6.

With this blast furnace hoisting equipment, 2,500 tons of material are handled in 24 hours. There are two tracks and two sets of cars, one handling the coke and lime, and the other hoisting cars of ore, the latter weighing four tons, and the former two tons. The electric hoist is capable of raising these cars of coal, coke and lime to the top of the blast furnace, a hoist of 40 meters, in 75 seconds, 100 seconds being required for the complete operation, 25 seconds being allowed for dumping the car. These electric motors are of the direct current multipolar type, and capable of raising the cars of charging material weighing six tons, without difficulty Electric brakes are provided as well as hand brakes and automatic safety brakes. The motors each have a capacity of 100 h. p. and operate at a speed of 200 r. p. m. They are supplied with direct current from the power service wires at a pressure of 550 volts. The electrical equipment includes a switchboard provided with voltmeter and ammeter, as well as main switches, connected to the power service wires as shown in the ac-

Fig. 5—Automatic Self-Starting Device.

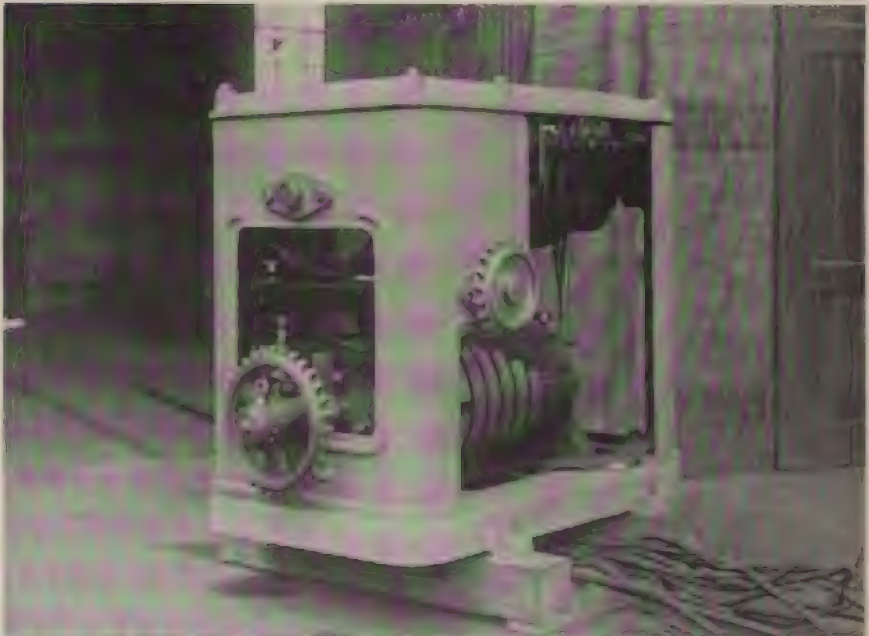


Fig. 6—Automatic Self-Starting Device.

companying diagram of electrical connections noted in Fig. 4, at 8 and 9. The controller is indicated at 1, the rheostat at 2 and the maximum and minimum automatic cut-outs at 4 and 5. The motors are compound wound, the shunt and series winding, as well as the brake magnet windings are indicated in the diagram by a, b, c, d, e, while incandescent lamps 13 and 14 are utilized as resistances. The armatures of the motors are indicated at I and II, and the protecting fuses are noted at 7. The electrical equipment of this hoisting apparatus for blast furnaces, was designed and constructed by the Felten & Guilleaume-Lahmeyerwerke-Aktiengesellschaft of Frankfort on the Main, Germany, while the mechanical construction was designed and built at Essie, Germany, by the E. Wolf Aktiengesellschaft. It is maintained that these hoists are more economically operated by electric power, and are under better control than by the use of other power, all of the operations being controlled by a single attendant.

Latest Use of Locomotive Crane.

SPIDER.—"I tell you this beats building spider webs all hollow."

The above was received too late for insertion in our October number. By courtesy of *Leslie's Weekly*.

Relative Economy of Turbines and Engines at Varying Percentages of Rating.*

BY WALTER GOODENOUGH, ENGINEERING DEPARTMENT STONE & WEBSTER, BOSTON, MASS.

IT has become evident to most of us, from time to time, that what is needed in the power station is not so much more economical prime movers, but rather more intensive operation of the particular type of machinery which we now have. This paper has, therefore, been written with the idea that it might bring interesting discussion from many and be of assistance to some of the companies.

The assumption that fixed charges are spread over the whole 24 hours, and that the machine operates during the full 24 hours is, of course, not correct; but in the present instance where it is desired to bring out, rather the effect of the combination of fuel and fixed charge costs, instead of actual operation costs, this assumption is considered to be well taken. On this basis characteristic curves for engine-driven and turbine-driven units are produced.

It is assumed for the purpose of this paper that each plant is of one unit running 24 hours per day, and on this basis fuel costs and fixed charges per kilowatt-hour are plotted individually and then combined. No other costs have been taken into consideration, as the addition or subtraction of such constant costs as labor, heat losses etc., make little or no difference in the characteristics of the curves until these increases or decreases have assumed a very large size. It is further assumed that the labor costs for a single engine-driven unit will be fully as low as for a turbine, and this assumption has also been made for the maintenance of the respective machines. It is taken also that the extra heat turned into the feed water by turbine auxiliaries over those of engine auxiliaries will offset the greater amount of heat used in the work of driving the larger turbine auxiliaries.

In making the curve of fuel cost, the price of coal is assumed at $2.00 per ton, and the evaporation per pound of coal as 7½ pounds of water. On this basis, 1,000 pounds of water evaporated will cost 13½ cents.

In determining the fixed charges, the following percentages have

been taken for engine-driven units:

Interest	5 per cent.
Depreciation	12 " "
Maintenance	1 " "
Taxes	1 " "
Total	19 " "

For the same charges for turbine-driven units the percentages have been taken:

Interest	5 per cent.
Depreciation	10 " "
Maintenance	1 " "
Taxes	1 " "
Total	17 " "

In this tabulation interest remains standard at 5 per cent; the maintenance remains the same for both turbine and engine, as any good engine unit will not have a higher maintenance of itself and its auxiliaries than a turbine with its much more numerous auxiliaries. In considering depreciation, amortization has been neglected, and the depreciation deliberately placed high.

In the present state of the art we can expect to see developed in the near future prime movers and fluid generators (including the pieces of apparatus now known as boilers and gas producers) of such an increased efficiency that it will become necessary, for many reasons, to abandon our present units within a few years. We are assured by the makers of turbines that they are still exploring the field, and most of us have visions of high-economy gas-driven machinery at no distant date. So unsettled are the conceptions for the future of commercial economy in power generation that it cannot be but wise to place a high depreciation on our present machinery. Competition, local disturbances through municipal ownership, agitation and other commercial reasons will demand more than ever the supersedence of present-day designs for new ones of higher efficiency. The exact form in which "depreciation" is applied does not matter, the basic fact remains that machinery does depreciate, and the fact is not less true that the genus "stockholder" pays the depreciation. He may do it by default of dividends, held in a sinking fund by a careful administration, or by means of assessments, or interest on mortgages or bonds.

In regard to the first cost of the machinery under discussion it has been assumed that with the 500 kilowatt units the system in use will be 500-volt direct current. It is also assumed that the engine units will

have direct current generators, and the turbine units alternating current generators, requiring converting apparatus. It is further assumed that the engine will work with saturated steam and that the turbine will use superheated steam. We, therefore, assume the following costs for the engine unit:

Engine and generator	$45.00	per kilowatt
Condensing apparatus	4.00	" "
Foundations	3.00	" "
Total	$52.00	" "

On the same basis we assume that the turbine with saturated steam would cost as follows:

Turbine and generator	$36.00	per kilowatt
Condensing apparatus	6.00	" "
Foundations	1.00	" "
Motor generator apparatus and switchboard	22.00	" "
Total	$65.00	" "

In order, however, that full operating value from the stand-point of steam economy may be obtained from the turbine, it is necessary to install with our boilers some superheaters, and for this additional cost we should apply $4.25 per kilowatt, making a grand total for the turbine of $69.25.

In order to show the effect upon the combined kilowatt-hour cost of having to add converting apparatus, curve D in Fig. 1 has been made, based on a total first cost of $69.25, less $22.00.

For 1,500-kilowatt units it has been assumed that both the engine-driven and turbine-driven unit will generate alternating current, and on this basis there have been assumed the following costs:

Engine and generator	$35.00	per kilowatt
Condensing apparatus	2.25	" "
Foundations	2.25	" "
Total	$39.50	" "

On the same basis as the above we have:

Turbine and generator	$28.00	per kilowatt
Condensing apparatus	5.00	" "
Foundations	.50	" "
Superheater and piping	4.00	" "
Total	$37.50	" "

In the case of curves for 1,500-kilowatt units, it has been assumed, without question, that the engine will run with saturated steam and the turbine with superheated steam.

On the basis of all-sized units, operating alternating current, the 500-kilowatt turbine makes quite a little better showing of rated load efficiency against the engine unit than the 1,500-kilowatt size of turbine. The author would, however, suggest that the 1,500-kilowatt unit is probably the one size where conditions of total cost per kilowatt, fuel and fixed charges come nearest those of the engine For all sizes above 1,500-kilowatt the combined cost of the turbine unit draws rapidly away from the engine unit in the direction of lower cost, and it might be suggested here that if there were any one spot where engine builders desired particularly to apply refinements to their designs in the way of larger cylinder ratios, rejacketing, reheating and superheating, the 1,500-kilowatt size would undoubtedly prove the most fruitful for them. There is some question, however, as to whether the increased economies in steam consumption they might obtain would overcome the increased fixed charge cost due to greater expenditure to obtain these results.

As stated in the first part of this paper, it is of considerably greater importance in the immediate present to the station manager to consider how he may obtain the greatest economy from the units which he has, rather than where he can buy units having half a pound better steam consumption than what he has.

If we look at Figure 1, it will be noted that the fuel cost for the 500-kilowatt engine unit is at its lowest point at 90 percent rating, while with the turbine unit this best fuel cost comes near to the 120 percent rating, both with and without superheat. Now, if we add to this the fixed charges per kilowatt-hour, we see in our engine unit that the point of maximum economy is moved from 90 percent rating to 125 percent rating. Also, in our turbine units the point of maximum economy, when converting apparatus is included, is moved up to about 145 percent rating from 120 percent. When the converting apparatus fixed charge is not included, we find the high point of total economy has dropped back to around 140 percent.

From these characteristic curves; therefore, it becomes quite apparent that we cannot carry our steady loads per unit any too near 100 percent rating. It would not, of course, appeal to the average careful station manager to operate his individual units at continuous loads above 100 percent. Consideration has to be taken of the ability of the generator to stand continuous overload, and a margin has also to be provided for

suddenly applied overloads or swings. It would seem, however, that there should be no valid excuse in a well managed plant for not maintaining the loads as near as possible to 100 percent rating of each individual machine. It is well known that engine builders have, for quite a number of years, built their machinery, for point of maximum economy, nearer to 75 percent rating than 100 percent rating; they assuming that the loads in a station would always be under, rather than up to or over 100 percent; and, therefore, they have put their machinery where it would show up the best under loads which the average engineer feels he can run. It is apparent, however, from these curves that the true econ-

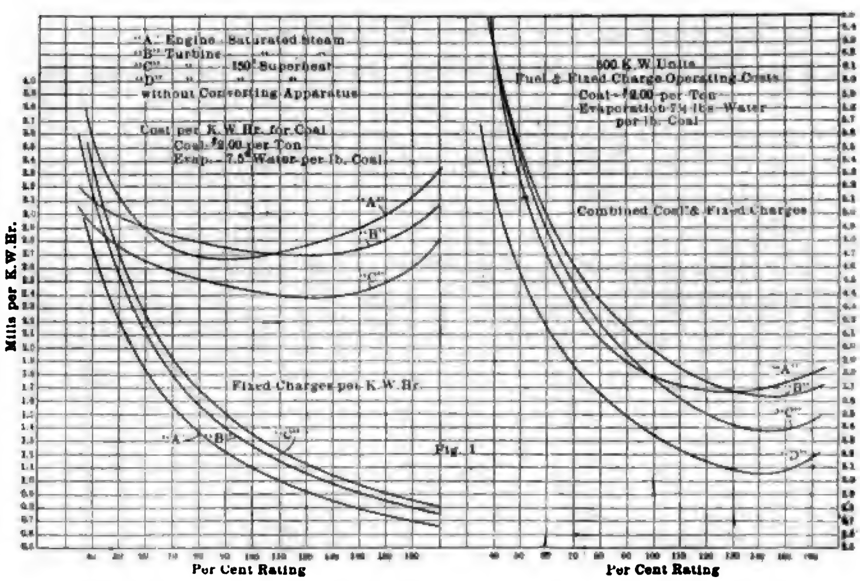
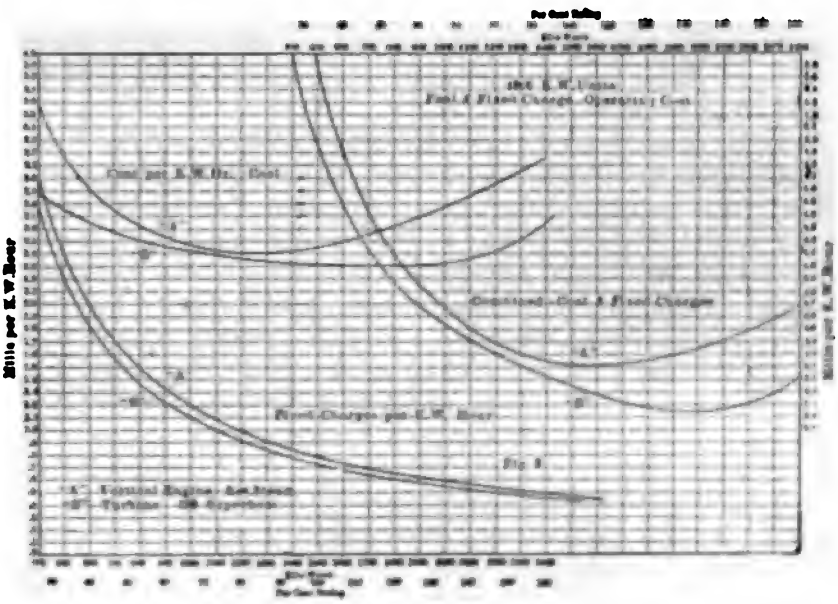


Fig. 1

omy of the plant is by no means the steam economy of the plant, and it is also seen that the engine builder, on the basis of steam economy alone, did not shove his point of best economy far enough back, after all. On the other hand, it appears that the turbine builder has not yet reached consideration of this point, and he is building his turbine for a rating which carries the point of combined economy to considerably over 100 per cent rating and close up to the point where the total economy begins to fall off sharply, and the capacity of the machine is being rapidly absorbed. In the particular instance of the 500-kilowatt units, it would seem that the engine overload capacity was not too far in excess of its generator capacity; but in the case of turbines it is apparent that the size of the turbine for the same size generator should be considerably

decreased and means taken to insure, after such decrease, that overloads can be readily carried by the machine. Such changes as those would then bring the point of maximum total economy back to the place where it is actually possible to operate the machines under steady loads in the average power station furnishing current for a street railway.

However, the turbine builder has not supplied us with this very desirable machine, and it, therefore, becomes necessary for us to make the best of what we have. It would seem wise to fix as high as possible the loads at which each individual machine in the station should operate, and then maintain these loads as continuously as possible. When variations have to be taken they should naturally be taken by increasing the



load on the machines already in service, rather than to put in another unit and underload it, or all of the units in service. There is a question of reliability and safety of service, which comes in here, and which the station manager will, of course, have to settle according to the character of his load and the number and size of his units.

The foregoing naturally brings up the question of selection of the size of units in new developments or renewals. The end of all construction should be the minimum combined cost per kilowatt hour of operation, and, therefore, it behooves us in selecting our new units that we study carefully not only the immediate loads to be applied, but also the expected future loads. It is to be suggested that many managers can, with

good success, chart the daily load and fix almost precisely, from day to day, the time when each unit shall enter upon its work and the load which it shall carry. The average station engineer has too limited a view, from reasons of training, to take any initiative of this sort. He will often require considerable persuasion to get him over the fear of running his machinery too hard. It is the author's general experience, however, that with someone to start such a man authoritatively along the lines of better economy, that he becomes, not only anxious to make a better showing, but his pride in such showing is very marked.

The general statement which has been made that turbines have a flatter load curve than engines is decidedly misleading when considered from the standpoint of total cost per kilowatt-hour. Inspection of the combined curves on both Figures 1 and 2 show that at 100 percent rating the rate of change in cost per kilowatt-hour of operating the turbine is decidedly greater than for the engine. It is seen from this curve that the engine, with its point of steam economy at 85 percent or 90 percent rating, has at 100 percent rating a much flatter curve of total economy. If we will inspect Curve D, Figure 1. we will see that for an increase in load, from 75 per cent rating to 100 per cent rating, the increase in economy on the basis of which this curve is made will be 11 percent. Of this 11 percent gain in total cost the steam economy gain is only 4.7 per cent, while the fixed charge gain is 23 percent, or four times as much gain as in steam cost. These percentages, of course, will bear quite some changing under different conditions, but it must be borne in mind that the characteristics of the curves will remain very generally the same.

Again, as stated in the first part of the paper, it is not strictly correct to assume that the unit is to run 24 hours a day at a certain load. However, it should be noted that applying the fixed charges to the unit for the actual number of hours run each day will increase these fixed charges per kilowatt-hour, and more than ever increase the effect on the total combined economy, shoving the point of maximum economy still further up into the overloads. The decreasing of the fixed charges per kilowatt-hour means, however, an increasing of the steepness of the fixed charge curve below 100 percent rating, thereby accentuating from the other standpoint the marked effect upon total costs which fixed charges have at all ratings below 100 percent or thereabouts.

The effect of the increase in the cost of coal, while not affecting the strict character of the curve of cost per kilowatt-hour, does somewhat flatten out the inclined portions of the curve.

Thus it may be truthfully said that the curves A. B, C and D will at all times retain their characteristic forms, and that being the case, what-

ever has been shown in this paper as to relative costs for different percentages of full load is very closely true. The increase or decrease of either fuel cost or fixed charge cost changes but very slightly the relation of the individual fuel and fixed charge curves to the combined curve.

The point has been raised that, after a plant is once installed the fixed charges do not enter into the economy of operation, and that, therefore, the plant should be run at its lowest steam consumption. If, however, it is legitimate and necessary to figure fixed charges per kilowatt-hour in preliminary estimates, it appears to the author that they should be considered when the plant is in operation, for two reasons.

First—The operating reason, that with the load usually carried by operating engineer, full value is not being obtained from the investment. A monthly report which shows fixed charges per kilowatt-hour generated should be of immense value to the operating superintendent in determining whether his plant is receiving the particular and discriminating attention which such a large investment warrants.

Second—The investment reason, that a machine which has the lowest combined cost per kilowatt-hour at the individual loading that is carried, is the most desirable to continue in the installation. Manifestly a machine which has a combined kilowatt-hour cost lowest at 100 per cent rating is better than one having its lowest cost at 140 percent rating. The first machine will probably have a smaller steam end for the same generator than the second unit. By adding automatic overload devices, costing little money, to the first machine it can be made to operate up to the full overload capacity of the generator in taking care of peaks of short duration.

The author would point out that this is not a consideration of station load factors, but rather a consideration of the economy in operation of individual units, and also economy in their selection as affected by type and design.

In conclusion, the author would additionally point out that the gains indicated herein for turbine and engines are, to a greater or less extent, true for all other station apparatus, and perhaps no more true than in the case of boilers whose load and operation seem equally as far buried under misapprehension as are the generating units.

Presented before the American Street & Interurban Railway Engineering Association, Columbus, Ohio, October [illegible]

INDUSTRIAL PROGRESS.

A Record-Breaking Cargo.

THE steamer J. Pierpont Morgan, belonging to the Pittsburg Steamship Company's fleet has, as was expected, already begun to break cargo records of the great lakes. She is the first of the 600-footers to go into commission and is, for the present, the largest vessel on the lakes. She was sent on her maiden trip light from Chicago to Escanaba for a cargo of ore.

She loaded 13,294 gross tons, or 14,889 net tons and delivered it at South Chicago, drawing 21 feet 6 inches. This is 956 tons more than the steamer E. H. Gary carried when she made the record between these two ports. Of course, it is understood that on this run there is no limit to draught and the cargo is, therefore, somewhat greater than that which can be carried to Lake Erie ports. At present the Gary holds the record for Lake Superior with a cargo of 10,629 gross tons, or 11,904 net tons, carried from Ashland to South Chicago.

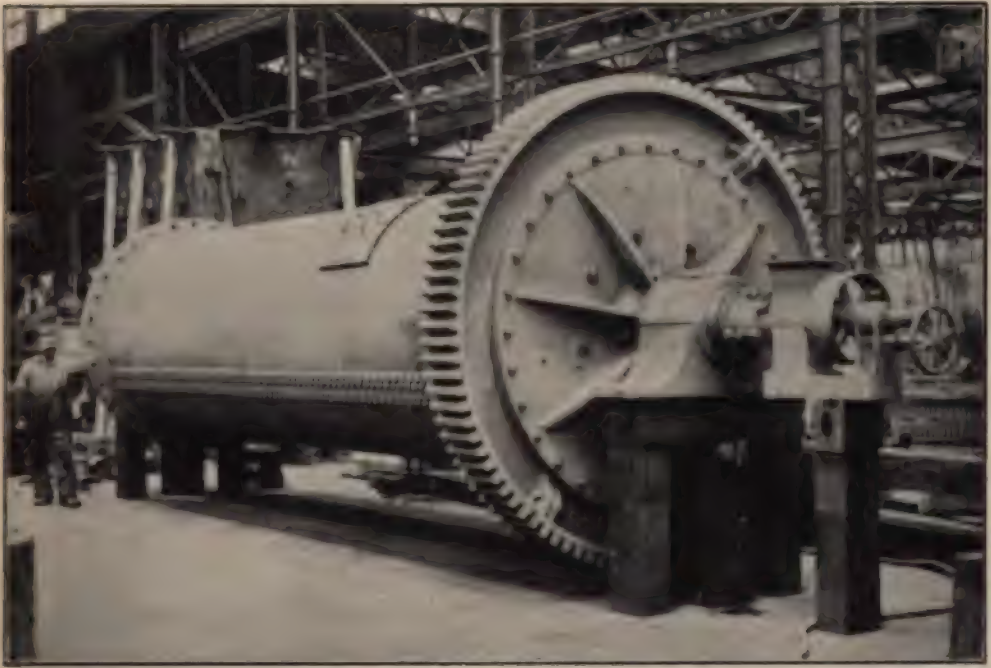
Growth of the Cement Industry.

THE Portland Cement industry in this country presents one of the most marvelous instances of growth on record. The use of cement for all forms of construction—for railroad, dock and harbor work, great office buildings, factories, hotels, dwellings, and a thousand and one other things—has occasioned the amazing increase in the output in the United States from 42,000 barrels in 1880, to 35,000,000 barrels in 1905, or over 800 times as much; whereas in pig-iron production the output in 1905 was only about six times that of 1880. This marvelous growth of the cement industry, however, has in no way interfered with the growth of the iron industry. To the contrary, cement has come as an auxiliary to help maintain the vast building activity, preventing an iron and steel famine, which would have upset all building operations throughout the country.

As concrete has supplemented iron so has it helped the lumber situation through its use

in many forms of construction where timber would otherwise have been essential. The scarcity of timber is growing to an alarming extent. Experts have placed the limit of supply at 35 years. The advent of the cement industry is therefore important in helping to save the American forests from complete destruction.

The manufacture of all this cement requires a vast amount of machinery. Many plants have sprung up within the last few years in various parts of this country, whose capacities run up into thousands of barrels daily. Contracts for cement-making machinery calling for an expenditure of hundreds of thousands of dollars are of frequent occurrence to the large cement machinery manufacturers. What is said to constitute the largest individual order ever placed for Tube Mills for the grinding of cement clinker is one recently placed by the United States Steel Corporation. This order calls for 47 tube mills, 5 feet in diameter by 22 feet in length. Twenty of these are to be installed in the plant of the Carnegie Steel Company at Homestead, Pa., and twenty-seven are for an extension to the immense modern cement plant of the Illinois Steel Company at Buffington, Indiana. This entire order was awarded to the Power and Mining Machinery Company, Cudahy, Wisconsin.



Tube Mill for Grinding Cement Clinker.

In addition to the order for the 47 tube mills above mentioned, the Power and Mining Machinery Company has also booked an order for 14 tube mills, 5 feet by 22 feet, and a complete crushing plant consisting of large and small crushers and rotary screens for the new plant of the Sandusky Portland Cement Co. at Dixon, Illinois.

Mr. George W. Jackson has resigned as Chief Engineer and General Manager of the Illinois Tunnel Co., of Chicago, Ill., and after an extended trip to Europe will open a general consulting engineering office in Chicago. Mr. Jackson planned and supervised the construction of the entire subway system of the tunnel company, embracing some 46 miles of tunnels now ready for operation.

The Value of Ashes.

IT is valuable for grading streets, for filling in and making land which can be utilized or sold; for filling in swamps or malarial places, and improving the health

conditions of a locality; for an ingredient for concrete.

The value as filling can only be determined in each locality. In New York City, the ash collections have varied in value from the free cost of final removal to from 12 to 19 cents per cubic yard, but these prices are not always obtainable. Ordinarily the city has to pay a bonus to private parties for the ash removal, which has been as high as 60 cents per ton, and as low as 10 cents. The city, however, saves the cost of carriage for final disposition. Considerable filling has been accomplished on property owned by the city, and the land so recovered has been rendered very valuable, at the cost of disposal of the material which had to be removed.

The value of ashes for concrete mixing is small as the demand does not equal the supply. Mixed ashes from house stoves and furnaces are not as good for the purpose as steam-ashes.

Its heating value as a constituent of a fuel is dependent on the quantity of unburned coal contained. This heating value can be increased from 20 to 30 per cent by siftingg out the fine ash.—*Disposal of Municipal Refuse, Parsons, 1906.*

Essentials to the Good Manufacture of Cement.

FROM the standpoint of the production of well-made material, in contra-distinction from that of economy, the essentials to the good manufacture of cement are:

(1) Proper raw materials; so that a mixture containing the correct proportions of silica, lime, alumina, and iron may be made from them, and also containing but a small percentage of the injurious constituents notably magnesia, sulphur, and the alkalies.

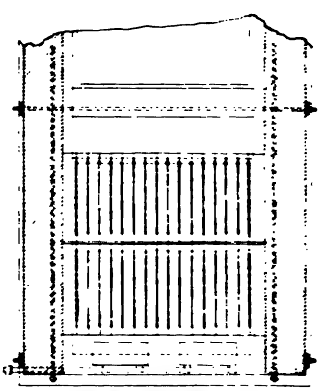
(2) Correct proportioning; it being impossible to produce good cement from an incorrectly proportioned mixture.

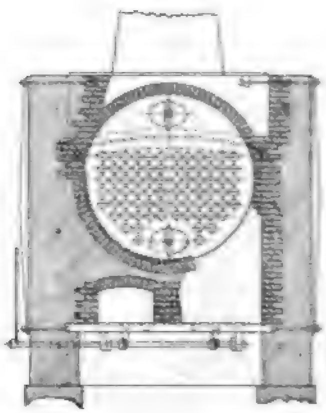
(3) Fine grinding of the raw materials. When the raw materials are calcined, the formation of the different constituents of cement takes place by a process of diffusion, so that only those particles which exist in a very finely divided state are capable of combining properly. The most common cause of unsoundness in cements is insufficient grinding of the raw materials.

(4) Proper burning. If the temperature of burning is too high or too low, or if the duration of the calcination is either lengthened or shortened, the character of the product will be vitally affected, and if varying beyond a very limited range the material suffers exceedingly in quality.

(5) Sufficient storage. Both the clinker before final grinding and the finished cement should be kept in storage for a considerable time in order that any expansions that may be present will have sufficient time to absorb water and carbonic acid and thus become inert. Most cements require from 2 weeks to a month for this action to take place, and should never be used in less than that time. As a rule, the more finely the raw materials are ground, the less time is necessary for storage

A New Bearing Bar.

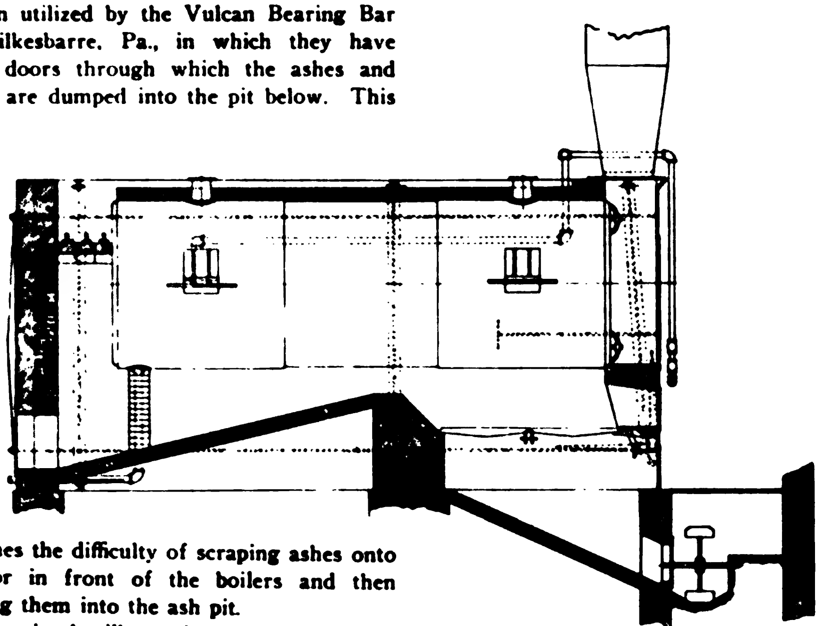




IT has long been a custom of firemen to draw the ashes from under their boilers out upon the floor and if in a heated condition they are quenched and the smoke and steam and dust resulting causes much annoyance.

No fireman probably has been without this experience and knows all the great inconvenience of such a process. Many boilers of the return tubular type have a wide plate between the boiler front and the grate bars on which some firemen throw their damp coal and allow it to coke some before shoving it on the fire.

This "Dead Plate" as it is sometimes called, has been utilized by the Vulcan Bearing Bar Co., Wilkesbarre, Pa., in which they have formed doors through which the ashes and clinkers are dumped into the pit below. This



overcomes the difficulty of scraping ashes onto the floor in front of the boilers and then shoveling them into the ash pit.

As seen in the illustrations these doors are controlled by a lever and dropped in such a way that they throw the ashes forward. This bar has every recommendable feature, in view of the fact that no ashes need be turned out upon the floor, and create smoke and dust.

A small fender is sometimes placed in the fire doors, over which the fire tools are handled which avoids any danger of ashes dropping out on the floor.

Constructing Concrete Piles without Forms by Rolling.

IN molding reinforced concrete piles exceeding 30 or 40 ft. in length, the problem of molds or forms becomes a serious one. A pile mold 50 or 60 ft. long is not only expensive in first cost, but is costly to maintain, because of the difficulty of keeping the long lagging boards from warping. To overcome these difficulties a method of molding piles without forms has been devised and worked out practically by Mr. A. C. Chenoweth, of Brooklyn, N. Y., and described by *Engineering and Constructing*. This method consists in rolling a sheet of concrete and wire netting into a solid cylider on a mandril, by means of a special machine. Fig. 1 is a sketch showing a cross-section of a finished pile, in which the dotted line shows the wire netting, the hollow circle is the gas pipe mandril, and the solid circles are the longitudinal reinforcing bars.

In making the pile the netting is spread flat, with the reinforcing bars attached as shown at (*a*), Fig. 2, and is then covered with a layer of concrete. One edge of the netting is fastened to the platform, the other edge is attached to the winding mandril. The winding operation is indicated by sketch (*b*), Fig. 2. Fig. 3 shows the machine for rolling the pile. It consists of a platform *a* and a roll *b*. The platform is mounted on wheels and is so connected up that it moves back under the roll at exactly the circumferential speed of the roll; thus the forming pile is under constant, heavy pressure between the roll and platform. When the pile has been completely rolled it is bound at intervals by wire ties; the wire for these ties is carried on spools arranged under the edge of the platform at intervals of 4 ins. for the first 10 ft. from the point and 6 ins. for the remainder of the

length. The binding is done by giving the pile two or three extra revolutions and then cutting and tying the wire; then by means of a long removable shelf which contains the flushing mortar, as the pile revolves it becomes coated on the outside with a covering that protects the ties and other surface metal. Finally the pile is rolled onto a suitable table to harden.

An exhibition pile rolled by the process described is 61 ft. long and 13 ins. in diameter. This pile was erected as a pole by hoisting with a tackle attached near one end and dragging the opposite end along the ground exactly as a timber pole would be erected. It was also suspended free by a tackle attached at the center; in this position the ends deflected 6 ins. Neither of these tests resulted in observable cracks in the pile. The pile contains eight 1-in. diameter steel bars 61 ft. long, one 2½-in. pipe also 61 ft. long, 366 sq. ft., or 40.6 sq. yds. ½-in. mesh 14 B. & S. gage wire netting, and 2 cu. yds. loose concrete. Its cost for materials and labor was as follows:

Materials—

Gravel, 28.8 cu. ft., at $1 per cu. yd.	$ 1.05
Sand, 19.8 cu. ft., at $1 per cu. yd.	.73
Cement, 3 bbls., at $1.60 per bbl.	4.80
Netting, 40.6 sq. yds., at 17½ cts. per sq. yd.	7.10
Rods, wire, etc., 1,826 lbs., at 2½ cts. per lb.	45.65
Total	$59.33
Mixing 2 cu. yds. concrete, four men 1 hour, at 15 cts. per hour	$ .60
Placing concrete and netting, four men 30 mins., at 15 cts. per hour	.30

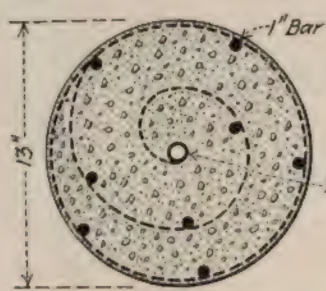


Fig. 1.

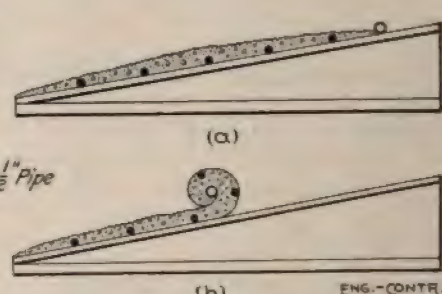


Fig. 2.

Fig 3.

Winding pile, four men 20 mins., at 15 cts. per hour	.20
Removing pile, four men 10 mins., at 15 cts. per hour	.10
	$1.20
Grand Total	$60.53

This brings the cost of a pile of the dimensions given to about $1 per lin. ft.

Novel Use of a Steam Shovel.

A very clever scheme in connection with a steam shovel was noted on a recent visit to one of the Tennessee Steel & Iron Company's mines. The mine is of the open pit style and the steam shovel is used to excavate the ore and load it into small cars, which are then hauled up an incline to the washers, etc. The banks are very high and the ore soft brown hemitite. The shovel is making a "thorough" cut, that is, cuttings its way right into the bank, having just room enough on each side for the cars to be pushed up under the dipper of the shovel when it is swung at right angles to the body of the shovel. Occasionally the bank caves in and buries the car track along side of the shovel so that it is necessary to clean it off before the cars can be loaded. To do this an ordinary bowl scraper, provided with a chain about 10 or 12 feet long, having a big ring in the end is used. This ring is hooked over one of the teeth of the dipper. Then by swinging the boom and at the same time thrusting in or out the dipper, the scraper is dragged along the track and around in front of the shovel in such a way as to clean the track perfectly and deposit the fallen ore in front of shovel from which place it is loaded in the cars. After the shovel has dug to its limit and is moved ahead the scraper is used in the same manner to clean up a level space on which to extend the dump car track.

Welding Broken Dredge Bucket Arms in the Field.

THE broken bucket arms of clam-shell dredges of large capacity now being used in the construction of a harbor in the eastern end of San Pedro Bay, 27 miles from Los Angeles, Cal., on the Pacific Ocean, have recently been welded by the Thermit process near the site of the dredging operations and the buckets placed in service again with very slight loss of time. The harbor construction in which the dredges are employed is being carried on for the Los Angeles Dock & Terminal Co. by the North American Dredging Co. The national government is also making extensive improvements at the outer end of San Pedro Bay, which was originally an exposed roadstead with a shallow channel leading up to the point where the terminal company is now carrying on its improvements. The latter are entirely independent of the government work, however, and will be reached by an artificial channel having 30 feet of water at mean low tide and protected by breakwaters.

Showing where break occurred.

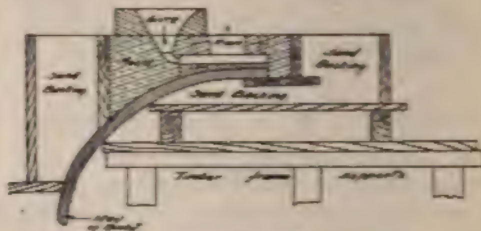
The buckets of the dredges used in this work have a capacity of from 4½ to 6 cubic yards, those of the latter size weighing 12 tons without any attachments, when empty. The welding of this broken arm on one of the 6-yard buckets is indicative of the maner in which the repairs were carried on. The breaks on this bucket occurred both on the outside and inside arms, at the junction of the latter with the bucket and through the first line of rivet holes. Immediately after the break the arm separated completely from the bucket, the space between the two being 13 inches. This space was closed up by heating the opposite arm, after which it was kept closed by a chain and turnbuckle. The bucket was then picked up and laid on its side on a scow on which the welding was done.

The Thermit welding process utilizes the chemical reaction between finely divided aluminum and iron oxide, producing liquid steel at a temperature of about 5,400° Fahrenheit, without heat or power from the outside. The

General View of Mold

reaction between the powdered forms of aluminum and iron oxide is started by applying a match to a chemical ignition powder. During this reaction the iron oxide is broken down, its oxygen combining with the aluminum to a slag, while the iron being the heavier sinks to the bottom of the crucible in which the reaction is allowed to take place.

In welding these bucket arms a slight staging was built up around the bucket to facilitate operations, the bucket having first been firmly blocked in position. A mould consisting of a mixture of fire clay and sand, made up in two parts in iron flasks, was then placed around the fracture. Owing to the extremely high temperature existing during the process of welding this mould had to be made absolutely dry to prevent the generation of steam and a resulting porosity of the weld. When the mould had been placed it was well luted and banked up with dirt on all sides to prevent the possibility of leakage. The finely powdered chemicals were then placed in a conical-shaped magnesia-lined crucible sus-



Section of Mold

pended from the staging directly over a pouring hole in the mould. Immediately before filling the crucible the parts to be welded were heated to a red heat with a blow torch. The crucible was then filled and the chemical reaction started. This reaction lasts about 30 seconds but a few seconds more than that

Ready to Pour

The Bucket in action

were allowed in order to permit the steel and slag to become thoroughly separated in the crucible. The steel was then tapped into the mold by driving in a small pin suspended from the bottom of the crucible, the outlet of the latter being directly over the gate of the mold. The steel flowed into the mold, through the fracture and around the parts to be welded, and on cooling amalgamated with the latter and formed a collar or reinforce-

ment which is shown in one of the accompanying illustrations.

The weld on this arm required 250 pounds of the mixture of aluminum and iron oxide, to which were added 56 pounds of steel rivets. The steel produced by the reaction between the aluminum and iron oxide contains 0.10 per cent carbon, so the steel rivets were added to increase the tensile strength of the resulting steel. When larger welds are made by this process it is customary to add 15 to 20 per cent of steel punchings, which are completely reduced during the reaction.

The repairs were carried on under the supervision of Mr. L. Heyenmann, consulting engineer for the Goldshmidt Thermit Co.

Reprint from Eng. Record. Illustrations from Goldschmidt Thermit Co., N. Y.

A New Transmission Chain.

In the accompaning illustrations will be seen a make of chain belt that is something entirely new in the chain line.

It is only manufactured in six sizes and in those six we give a breaking strain of 15,000 lbs., where it requires 160 sizes of the old style to give the same breaking strain. The belt requires less space and is a saving of power; it also runs more accurately and does not wabble, as it works on the principle of a pinion gear and can be used within 17 and 24" centers as a direct drive for motors.

They are running the chain at a speed of 850 revolutions from the main shaft and it is practically noiseless. It does not become clogged from grease or dirt, thereby saving friction. It is also the only cross belt chain that will work within 4' centers; this applies to the smaller sizes and 8 to 12' on the larger sizes; also running at a quarter turn on the larger sizes within 18' enters and it is giving entire satisfaction. It is used in equipping paper mills, cotton seed oil works, tanneries, breweries, fertilizer works, sugar refining works, and in fact everything in the line of business where chain belt can be used. It is also used extensively for coal conveying, wood working machinery and concrete mixers.

This chain is the product of the Link Chain Belt Co., 52 Dey St., New York.

Another Big Iron Ore Deal.

Republic Iron & Steel Co. Gets Alabama Tract.

New York, October 15.—The Republic Iron & Steel Co. has acquired the Potter tract of land in Alabama, which is estimated to contain 72,000,000 tons of iron ore.

The transaction is the largest of its kind in years with the exception of the lease of the Hill ore properties by the United States Steel corporation. The Potter tract contains 1,800 acres and it is figured in the 40,000 tons of ore, yielding 38 per cent. iron at the furnace to the acre. The Republic Iron & Steel Co. paid $800,000 for the tract, of which $700,000 is in guaranteed 5 per cent. bonds and $100,000 in cash, to M. L. Potter of Brooklyn.

Bridge Men Are Fined.

Ottawa, O., October 15.—The bridge agents and corporations indicted by the last grand jury were found guilty today of violating the Valentine anti-trust law. Judge Ogan fined each agent $500 and costs, and the corporations $750 and costs. The fines were promptly paid by the following:

Harry Hammond, J. J. Swigart, S. N. Fronizer, William Cleveland, Canton Bridge Co., Mt. Vernon Bridge Co., Massillon Bridge Co. and Champion Bridge Co.

Prosecutor B. A. Unverferth ordered the indictments nulled against the Brackett Bridge Co., Van Dorn Iron Works Co. and King Bridge Co.—*Cleveland Plain Dealer.*

Can Temper Copper.

M. J. Mulvaney, of Vandergrift, Pa., and native of Pittsburgh, has come out as a successful inventor of a process for the tempering of pure ocpper and a patent has been applied for his process. Mr. Mulvaney who is an iron molder, said he had been experimenting for 20 years and had finally discovered the process. A piece of copper in his possession was soft at one end and as brittle as steel at the other. The tempered end could scarcely be filed. Mr. Mulvaney said he had a number of offers from men who desired to place the product on the market, but he and his partner, Thomas Heferman, had declined all.

An Odd Invention.

In winter weather a motorman's hands are very apt to be numbed by the cold, causing him a great deal of discomfort and also rendering him unable to properly operate the brake and controller handles. The same is true of the pilot of a ship, the chauffeur, or any operator who is exposed to cold. A recent invention provides a very simple remedy for these troubles. The operating handle is made hollow to receive an incandescent electric lamp. At one side is a plug which, on being screwed in, will switch on the current. The heat radiating from the incandescent lamp will warm the handle, giving the motorman a comfortable handhold. As the chamber in the handle is hermetically sealed, all the heat developed by the lamp is given up to the handle, so that the operator is sure of having his hands comfortable, even in the coldest weather. The handhold will also aid in keeping the operator warm, as the palm of the hand is a large nerve center. It is obvious that instead of a lamp, a resistance coil would give equally good results.—*The Scientific American.*

Curious Facts About Panama.

The canal will run due north and south; not east and west.

You don't buy a grave in Panama; you rent it.

The bicycle has just struck the isthmus.

Panama hats are not made in Panama.

Tobacco is used as money in both Panama and the canal zone.

By-product Economy.

The flagging and curbstone propositions of the sandstone quarries are the busy end of the quarry business just now. If it were not for this use of No. 2 stock, which often makes a principal part of the profit of the quarry, the building stone would have to cost more money and this suggests that there are other by-products of the sand-stone quarry that could easily be worked up to contribute to the revenue of the operation. Sand-stone spalls, when ground up, make an ideal sand for many purposes, which find a ready market in these days, and there are few quarries that could not crush up the sandstone spalls into fine sand and pay for cleaning up the quarry, and thus eliminate a feature of the quarry that has always been considered a dead expense.

Explosive Compound.

An explosive compound has been discovered which will materially lessen the powder bill in many mines when this discovery comes into general use. The compound consists of a metallic nitrate or oxidizing agent, paraffine and benzine, and di-nitrophenol, while carbon and collodion may be added.

Wood-Preserving Process.

A process of preserving wood consists in submerging the wood in a mixture of chloride of zinc solution and creosote in a closed receptacle and subjecting said mixture to a constant pressure to force the liquid into the pores, with a device to agitate the mixture to prevent the settling of the heavier material.

Pipe Across Isthmus.

Los Angeles, September 12.—News was received from Panama Wednesday that the pipe line of the Union Oil Co., across the isthmus, was completed Tuesday. This line, which is 45 miles long, cost $500,000.

Gigantic Floating Crane.

The building of a vessel, or any other large construction which exceeds in size all its predecessors, always involves more or less machinery and equipment of proportions until then unheard of, and is likely to set a new standard for many and varied lines of industry. The new mammoth Cunarders, "Lusitania" and "Mauritania," now building, have not been behind in this respect. A gigantic floating crane is being used in fitting the "Mauritania" with her boilers and machinery.

The crane is mounted on a barge 90 ft. long and 77 ft. beam which has four sets of propelling machinery and a speed of six miles an hour. The crane will lift 140 tons at an outreach of 44 ft. beyond the front of the pontoon. Two other lifts are of 5 tons and 20 tons capacity.

A 150-Ton Scale Completed.

There has been completed for the Pennsylvania Steel Co. a scale said to be the largest ever built east of the Mississippi river. The equipment is 46 feet long, has a capacity of 150 tons, and is to be used for weighing structural iron work. Another scale of the same size is being built for the Pennsylvania Company. They are constructed by the Standard Scale & Supply Co of Philadelphia, Pa.

Electric Towage for Canals.

A new method of electrical traction, brought out by the most prominent electrical firm in Germany, is in operation on the Tetlow canal in Berlin, and is meeting new requirements to an extent that promises to revolutionize canal traffic. A double-rail system is used on a track gauge of 100 millimeters. The tests have proved that the new locomotives are efficient and extremely economical.

Experiments in electrical towage on the Erie canal, for whch New York State made appropriation several years ago, do not appear as yet to have brought any practical results.—*Southwestern Electrician.*

A New Waterproof Cement.

A waterproof cement has been patented in Germany. A mixture of vegetable wax and caustic lime, in boiling water, is added to unground Portland cement clinker and all ground together. The inventor makes the claim that one-half inch coating of this cement placed on a brick wall will render it absolutely waterproof. The formula is given as follows: To each 200 cwt. of cement clinker is added a mixture of three-fourths pound of Japan vegetable or berry wax, and one ounce of caustic lime which has been dissolved in fourteen pints of boiling water. These ingredients are thoroughly mixed, and when cooled are dried and ground very fine with cement clinker.—*Boston Transcript.*

A sea wall and breakwater is being built at Manzanillo, Mexico, to cost, when completed, $11,000,000 silver.

Considerable activity is observed in the erection of mustard-oil mills in the new province of eastern Bengal and Assam, India.

It is said that the "Culebra Cut," along the Panama Canal route, considering the amount of material taken out, would be equal to an ordinary irrigating ditch dug twice around the globe.

There are 17 blast furnaces in the Province of Liege, Belgium. They consumed in 1905, 24,670 tons of Belgian ores, 1,353,280 tons of foreign ores, and 154,560 tons of dross scrap, etc. The fuel consumption was coke 694,420 tons, and coal, 4,310 tons.

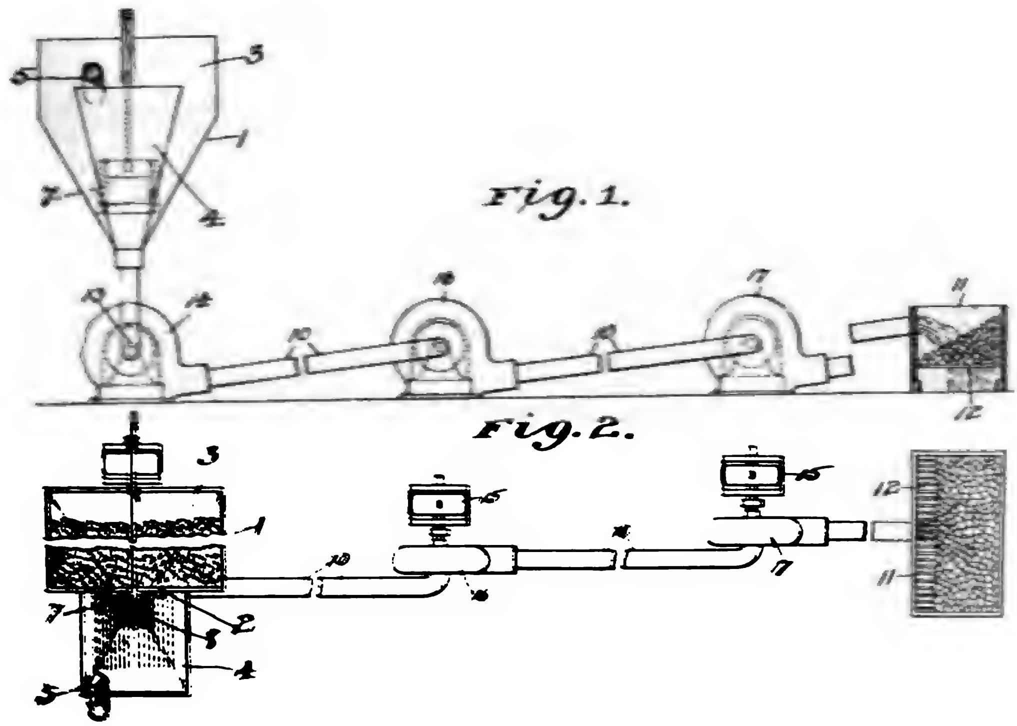
Consul H. Brunst of St. Etienne, France, thinks that the American runabout automobile might sell well in France. He says some light 6-horsepower autos were made in his district to sell at $700. They were not nearly so graceful as American machines of the same class.

Recent Inventions.

Specially reported for Browning's Industrial Magazine by C. LeRoy Parker, 639 F Street, Washington, D. C.

APPARATUS FOR TRANSPORTING SOLIDS.

THE accompanying illustration shows an apparatus for transporting solids recently patented by W. T. Donnelly, of Brooklyn, N. Y. The apparatus is especially designed for transporting solids in a more or less divided state.



The apparatus consists of a pipe line through which water is forced by relay devices, the water and the solid material to be propelled thereby being given a new impetus at intervals along the length of the line.

AUTOMATIC BUCKET.

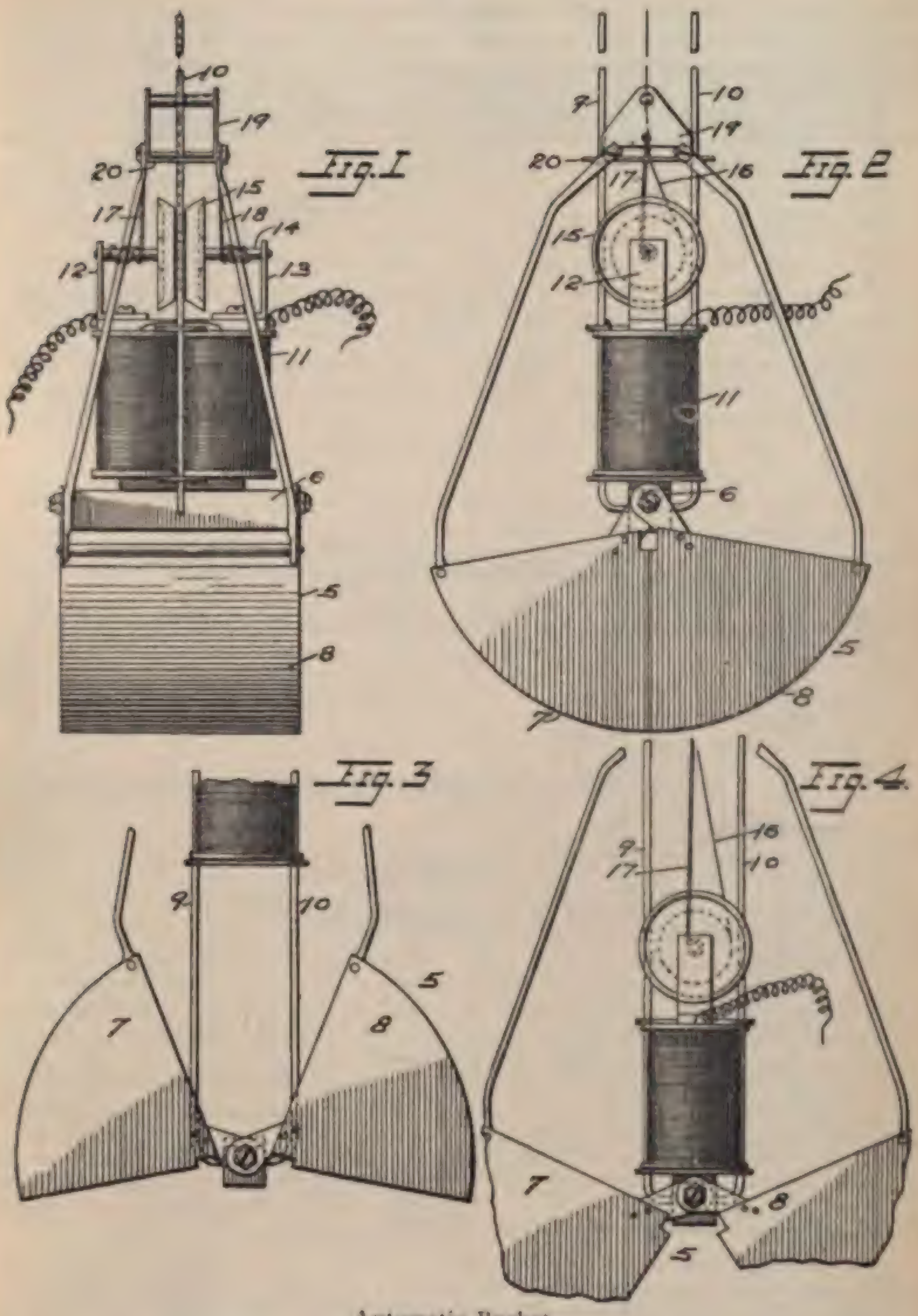
This invention relates to automatic buckets used in the unloading of coal or other material will contain several new and interesting features adapted to provide simple and effective means for mechanically operating the bucket when engaging and discharging the material being handled.

In operation the bucket being open is lowered to contact with the coal or other material to be handled, and when in engagement with the coal the weight of the bucket being released from the pulley 15 by continuing to lower the rope or chain 16 the electro-magnet will, by reason of its own weight, be lowered on the armature forming part of the cross-beam 6 and being magnetized by an electric current when coming in contact with the armature will engage the same and adhere to it so that when again raising the magnet the cross-beam will be raised and the buckets will be closed. When the bucket is closed it will be held in that position as long as the magnet is magnetized, but when the bucket is at the required point by breaking the circuit the magnet will be demagnetized thereby releasing the armature and the bucket will open, and the contents thereof will be discharged.

This bucket is the invention of Frank O. Clukies and Arthur M. Hazell, of New York, N. Y.

HOISTING AND CONVEYING APPARATUS.

This invention has reference to the class of hoisting and conveying apparatus which com-



Automatic Bucket.

monly includes a bridge, a trolley movable thereon, a bucket supported from said trolley by suitable ropes, guide-sheaves, and rope-take-up mechanisms by means of which the trolley may be moved backward and forward on the bridge and the bucket may be raised or lowered and opened or closed.

The object of this invention is to provide means whereby the trolley may be made to traverse the bridge in either direction while the bucket is being raised or lowered and which permits the bucket to be raised or lowered and opened or closed irrespective of the position of the trolley; and one of the special objects of the invention is to provide for the stated purpose means which permits the use of comparatively short hoisting-ropes.

In the use of the conveyer, the cars upon the trestle C are unloaded upon the conveyer S, and the coal or other material is carried by the conveyer to its head end and there discharged upon the tail end of conveyer U through the chute X. Conveyer U in turn discharges the coal through a chute Y upon the tail end of the conveyer J, from the head end of which it is discharged upon the storage pile B.

When starting the pile, the head of conveyer J is lowered as near the ground as possible without giving the conveyer so great an incline that the coal will slide on the belt, and then the conveyer is gradually raised as the pile grows in height, being kept a short distance above the apex of the pile. In this way

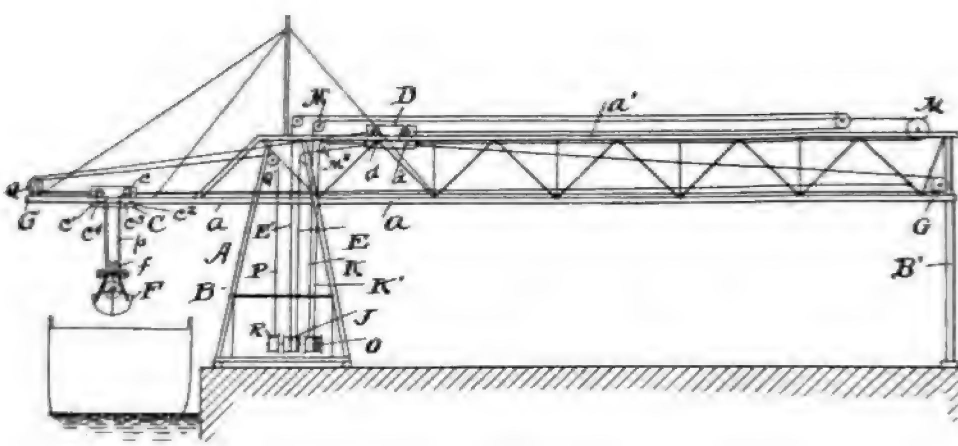


Fig. 1.

Hoisting and Conveying Apparatus.

the coal has only a slight drop from the conveyer to the storage pile and breakage is reduced to the minimum. In handling anthracite coal especially this is a very important consideration, as it is also in case of numerous other materials. It is often found necessary to store various materials to a height of seventy-five feet or more, and when a car or elevator or a fixed conveyer is used for the purpose material has to be dropped from the height of the bridge, and the resultant breakage is excessive.

The distinctly novel features of the invention reside particularly in the arrangement of the hoisting-ropes and their adjunctive devices intermediate of the bucket and the take-up devices, and also in the means which may be employed in connection therewith to cause the required movement of the trolley.

This apparatus is the invention of Frederick W. Lovell, of Cleveland, Ohio.

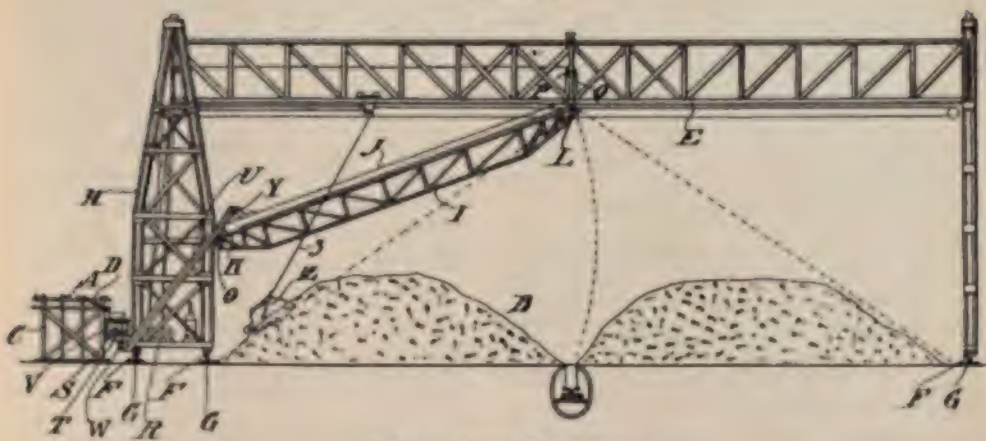
CONVEYER.

The conveyer shown in the accompanying illustration forms the subject matter of a patent recently issued to Lincoln Moss of New York City. The conveyer is of the bridge type and is especially intended for handling coal or ore.

APPARATUS FOR COALING SHIPS.

This apparatus, recently patented by W. A. Collins of New York City, was especially designed to receive loads of coal from carts or other conveyances and project the material

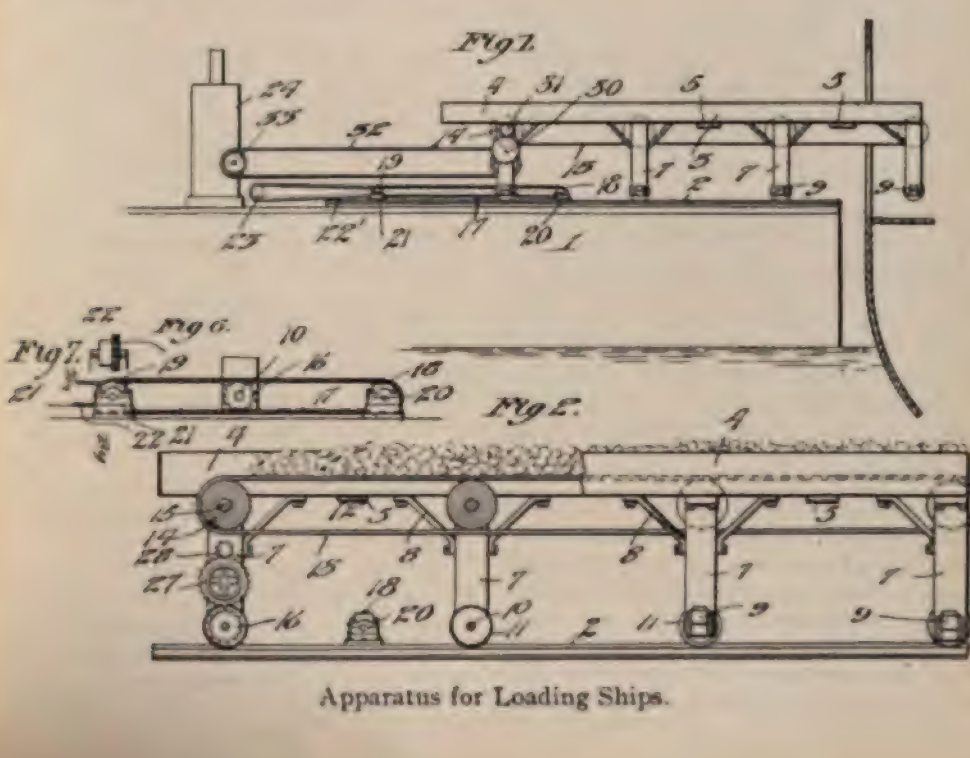
Fig. 1.



Bridge Type Conveyor.

through a coaling hole in the side of the ship.

In operation the carriage 3 is projected to extend at its outer end into the hull of the vessel through an opening therein, being outwardly moved by means of the chain 17 and associated gearing. Then the belt 32 is connected with the driving-pulley 33 to operate the endless conveyer 13. The loads of coal are dumped from carts or other conveyances upon the upper stretch 12 of the endless apron, which moves toward the vessel and discharges the same into the hull of the vessel at the outer end of the carriage. When the vessel has been supplied with its quota of coal, the apron is thrown out of operation and the driving-chain 17 reversely operated to retract or run the carriage back.



Apparatus for Loading Ships.

News Items.

The Automatic Smoke Preventer Co. have moved their offices from No. 5 Beckman St. to No. 1 Madison Ave.

At the recent annual meeting of the stockholders of the Allis-Chalmers Co., Mr. W. H. Whiteside was re-elected President.

J. F. Davis, formerly connected with the Pittsburg organization of the Atlas Engine Works, Indianapolis, has been transferred to the Company's Offices at Chicago.

J. M. Br[illegible]ucher of the Brownell Company, Dayton, Ohio, has resigned his connection with that company to accept the position of Assistant General Managership of Sales for the Atlas Engine Works of Indianapolis.

Howard E. Troutman, for over ten years connected with the Buckeye Engine Company and for several years manager of its Chicago Office, has resigned to accept the sales management, Corliss and High Speed Engine Department of the Atlas Engine Works, Indianapolis. Mr. Troutman's headquarters will be at the home office.

J. P. Johnston, for several years past the General Sales Manager for the Weber Steel Concrete Chimney Co., Chicago, has resigned to become Sales Manager, Water Tube Boiler Department of the Atlas Engine Works, Philadelphia. Mr. Johnston's offices will be at the company's plant in Indianapolis.

The Atlas Engine Works of Indianapolis, whose Chicago Sales Offices have for several years past been in suites 900-002 Fisher Building, will upon completion of the new Fisher Building in November, increase their present rather cramped quarters by the addition of several larger offices. Mr. Frank H. Baker, connected with the Atlas for over twenty years, will continue at the head of its Chicago organization.

The Electric Controller & Supply Co., Cleveland, Ohio, announces the opening of a Chicago office in the Merchants Loan and Trust Building, 135 Adams St., Chicago, Ill., with Mr. W. M. Connelly in charge. Mr. Connelly was connected with the Electrical Department of the Homestead Works of the Carnegie Steel Co. for [illegible] years and resigned his position there to become Electrical Engineer of the Ensley Plant of the Tennessee Coal, Iron & R. R. Co., at Birmingham, Ala., which position he held for three years and resigned to enter Central Station Work at Birmingham, Ala., and at Houston, Tex., where he organized and had charge of the Sales Department. Mr. Connelly enters upon his new duties fully equipped to take care of the interests of the Electric Controller & Supply Co. in the Chicago District.

An interesting little concentrating plant, with the heavy pieces of machinery sectionalized for mule-back transportation, was shipped recently to the Venture Corporation, at Guatemala City, by the Traylor Engineering Company, of New York. The plant was designed in New York and shipped with all parts complete and ready to set up. The building to enclose the plant was designed so that it could be built throughout of logs or poles.

The outfit consists of a [illegible] foot by 6 foot Grizzley, a 7-inch by 10-inch Traylor "Blake" Crusher, one gate irons, two 32 feet bucket elevators, two sets of 22-inch by 10-inch Traylor crushing rolls, one 10-inch Traylor plunger feeder for the rolls, one double Unit Centripact Screen, one single Unit Centripact Screen, one 24-inch sizer, one 30-inch sizer, one two-compartment Hartz Jig, one one-compartment Hartz Jig, an unwatering screen, two concentrating tables, one [illegible]-inch by 12-inch automatic steam engine, one 8-inch by 10-inch automatic steam engine, and two 2[illegible] horse power water tube boilers; iron work for settling tanks, belts, shafting and all the other details necessary to make up the complete plant and complete erecting plans were included in the shipment.

The Traylor Engineering Co., of New York, announces that it has entered into an agreement with the C. W. Knox Machinery Co., of Denver, by which the Denver firm becomes their exclusive representative for the sale in Colorado of their machinery for Mining, Sampling, Milling, Amalgamating, Cyaniding, Concentration, Smelting, Rock Crushing, Cement Making and Fuel Briquetting.

The high character of both houses makes this announcement one of great interest to mining men and others in Colorado who are users of the various classes of machinery made by the Traylor Engineering Company.

The C. W. Knox Machinery Co. has a his-

tory of almost phenomenal success. Mr. Knox is particularly well known throughout the Colorado district by his definition of success. "Success," he says, "is spelt 'h-a-r-d-w-o-r-k.'"

The house started in business in an unpretentious way in Boulder, Colo., in 1904. Today it owns and occupies an entire block in Boulder; it has a store and warehouse in Central City, Gilpin Co., and at Denver its main offices occupy two entire floors at 17th and Glenarn Streets, and it has warehouse facilities which enables it to carry constantly in stock $200,000 worth of machinery. The firm employs 63 men in its sales and office departments. It designs, builds and equips complete mills, and its stock enables it to make immediate deliveries of boilers, hoists, compressors, drills, and other machinery and supplies.

Mr. Knox and his associates have built up an enviable reputation for fidelity to the interest of their clients, and for their dependability, and as their motto is "Quality" in the machinery which they recommend their agreement with the Traylor Engineering Co. for the handling of its products is mutually complimentary.

The Cia Metalurgica De Julientla, S. A., of Mexico, has recently placed an order with the Traylor Engineering Company, of New York, City of Mexico, for a smelting plant, which tures

The plant is for the mines in the mountains of Naranjo, State of Guerrero, Mexico, and every piece of machinery is required to be sectionalized for mule-back transportation, so that no single piece shall weigh more than 300 pounds.

The ores to be treated carry silver-lead values, and the plant will produce silver-lead bullion for shipment.

Braschi & Co. will deliver the plant complete, with engine and boiler, and every detail requisite for its installation and operation; the complete plans for it having been prepared and forwarded by the Traylor Engineering Company.

Foreign Industrial News.

Consul E. T. Liefeld forwards from Freiburg an abstract from a Paris newspaper concerning a new electric lamp, which it is said will revolutionize the present system of lighting. The article was wired from Vienna and reads:

An Austrian chemist, Dr. Hans Kuzel, has, after many years' hard work, succeeded in constructing a new electric lamp, which he calls the Syrius lamp. As is well known, incandescent gaslight is cheaper than electric light, because the filament wires of the latter are very expensive and the glass bulbs soon wear out. Doctor Kuzel has now invented a new substitute for the glow-thread, by forming out of common and cheap metals and metalloids colloids in a plastic mass, which can be handled like clay and which, when dry, becomes hard as stone. Out of this mass very thin wire threads are then shaped, which are of uniform thickness and of great homogeneity. These two characteristics are of great value in the technics of incandescent lamps.

The Kuzel or Syrius lamp hardly needs one-quarter of the electric current which the ordinary electric lamp with a filament wire requires. Experiments, it is asserted, have shown that the lamp can burn for thirty-five hundred hours at a stretch. Another advantage is that the intensity of the light of the new lamp always remains the same, the lamp bulbs never becoming blackened, as is now the case. The new lamp, it is said, will be put on the market next autumn.

The British steel tube manufacturers have finally effected a combination, after years of effort, the importance of which is evident by the fact that the annual gross output of the firm concerned amounts to 300,000 tons, valued at over $29,000,000.

There are some 60 firms in the tube trade in the United Kingdom, and with the exception of one Glasgow house they have, according to the *London Economist*, entered into a compact to cease from cutting prices of a prepared schedule. Discounts on all kinds of tubes, except those for boilers have been reduced by 2.5 per cent, and prices of all sections of tubes for export have been advanced by 5 per cent on the net, these prices to hold firm until officially altered, which may be before long and on the upward grade. Boiler tubes have been left off the schedule because the independent Glasgow firm makes a specialty of these. Germany is not now a competitor in steel tubes, and it is anticipated by expert authorities that with this agreement an international arrangement for the regulation of the world's tube trade will sooner or later be evolved. Measures toward that object are to be at once undertaken. It is calculated that

out of the total British product 70 per cent goes abroad.

The British Iron Trade Association has ascertained that the total output of openhearth steel in the United Kingdom in the first half of [illegible] was 2,183,850 tons, which compares favorably with an output of [illegible] tons in the first half of [illegible] and [illegible] tons in the first half of [illegible]. The increase in [illegible] was shared by every manufacturing district.

According to Consul-General Guenther the celebrated works of Krupp at Essen, Magdeburg, Kiel, Annen, and at their ore and coal mines [illegible] in their employ [illegible] persons, of whom [illegible] were officials and clerks, against a total of [illegible] employees in the year before. The company's principal plant and accessories at Essen consumed as much water [illegible] as did the entire city of [illegible], which city has a population of [illegible] inhabitants. The gas made and consumed by the single [illegible] plant at Essen exceeds the gas consumption of the city of Elberfeld. Besides this, the electric plant of [illegible] arc lamps, [illegible] incandescent lamps, and [illegible] electric motors. The average daily wage paid [illegible]

Wood Supply of the World.

[illegible]

[illegible]

year. The following table is designed to show the importations of wood into the countries named:

	Cubic yards.
England	.. [illegible]
Germany	.. [illegible]
France	[illegible]
Belgium	[illegible]
Italy	[illegible]
Denmark	[illegible]
Spain	[illegible]
Switzerland	[illegible]

EXPORTATION OF WOOD.

	Cubic yards.
Russia*	[illegible]
Sweden	[illegible]
Austria-Hungary	[illegible]
Finland	[illegible]
Norway	[illegible]
Bosnia-Herzegovina	[illegible]

NEW WOODLANDS.

North America, Siberia, Africa, India, China, Korea, and South America still contain great unutilized and almost unknown forests. Nevertheless it would be well not to exaggerate the dimensions of these wood supplies. [illegible] forests are really composed of nothing better than mere bushes [illegible] Siberia [illegible] being systematically [illegible] will also begin in Korea [illegible] near future.

[illegible] America, however, [illegible] world, has not enough [illegible] own demand [illegible] acres of wooded [illegible] is dependent upon Canada, which [illegible] acres of forests, represents [illegible] largest single area of any country [illegible] world. Canada sends its entire surplus to the United States. Although large territories of forests, especially in China, Korea, [illegible] and South America, remain to be utilized [illegible] that the question of the future wood supply of the world, now occupying the attention of economists, will continue to excite great interest. The continuation of the present [illegible] consumption without comprehensive [illegible] foresting will within a century at the latest result in [illegible] very important scarcity [illegible] wood supply.

[illegible]

* Exclusive of Finland, Province of Russia.

Uncertainty of the Term Horse-Power When Applied to Boilers.

THE most common method of estimating the horse power of steam boilers is by means of the extent of the heating surface. The quotient obtained by dividing the total area of this surface by a certain unit of surface, represents the horsepower of the boiler. This method is used extensively by engineers, boiler-makers, and dealers in machinery. When the unit referred to is properly chosen, the results are oftentimes in accord with the facts as determined by tests later on. It will be noticed in this connection that, while the total area of heating surface in any given boiler remains the same, the horsepower may be made to vary between widely separated limits by simply changing the unit of surface selected as equivalent to one horsepower. For this reason, buying steam boilers with capacity expressed by a certain number of horsepower has proved to be very unsatisfactory in a large number of cases and has led the purchaser to believe that the dealer or boilermaker, as the case may be, acted dishonestly. Paradoxical as it may appear to some, it is possible for a purchaser unfamiliar with the methods employed in boiler practice to be deceived by strictly honest means, having no one but himself upon whom to cast the blame for subsequent failures. It is the purpose here to illustrate how this may readily be accomplished and how it is being done almost daily.

The method outlined above of finding the horsepower of a boiler gives what is generally called the commercial horsepower, or the commercial rating.

An instance serving to illustrate the flexibility of the horsepower method of rating boilers when only the heating surfaces are considered, is that of a gentlemen in Michigan who owned a tract of timber land and desired to reduce the trees to lumber on his own property. He purchased a saw mill of one party and a throttling slide-valve engine of another, both the engine and mill being second hand. The boiler had to be purchased new, and after some correspondence with builders of boilers their agents called and endeavored to sell him a boiler.

The sawmill required 45-brake horsepower when sawing the average sized log, and the engine developed 50 horsepower with a boiler pressure of 80 pounds and the cut-off set for one-half stroke. The purchaser had been cautioned not to buy a boiler of less than 15 horsepower more than the engine and, as will be seen, used this advance information, as he supposed, to good advantage.

One agent offered a boiler of 55 horsepower, containing 700 square feet of heating surface, and, to prove the rating liberal, cited an instance where a boiler of the same size was furnishing steam to a 75 horsepower Corliss engine without the slightest inconvenience. While the mill owner was trying to decide whether or not to accept the offer, another agent called and informed him that it would not be good economy to attempt to run the 50-horsepower engine with a 55-horsepower boiler. The latter agent offered a boiler of 65-horsepower at the same price and, of course, effected a sale. The latter boiler contained a trifle more than 670 square feet of heating surface.

According to the figures presented by the agents, both were right and no doubt were perfectly honest in their representations; at the same time, it is evident that the boiler credited with the greater horsepower was really the smaller of the two, although the external dimensions were the same. In the first instance the agent employed a unit of surface of 12½ square feet as equivalent to one horsepower, while the second selected about 10⅓ square feet.

This incident is cited to illustrate the fact that when buying steam boilers by the horsepower, as this term is generally employed, the extent of heating surface expressed in square

feet should be selected for comparison instead of the figures representing the commercial horsepower or commercial rating.

When the so-called 65-horsepower boiler was put into service it was necessary to force the fires continually in order to produce the required amount of steam, and it was with considerable difficulty that the owner was dissuaded from believing that the agent acted dishonestly.

The unit area of surface equivalent to one horsepower [illegible]

[illegible]

mercial rating, ask an engineer what sized engine the boiler will be capable of supplying with steam economically. If he is conservative in his estimates he will probably say, from 80 to 100 horsepower, depending upon the style of engine employed. When the unit area of surface equivalent to one horsepower is given he will be able to designate the style and size of engine best adapted. But here is where the uncertainty of the horsepower method is felt, because it is not customary to state the unit area when giving the horsepower of a boiler. It is no doubt readily comprehended how a person unfamiliar with boiler calculations may be easily led to select a boiler wholly unsuited to his requirements.

It becomes almost necessary to first know the dimensions of the boiler and second the weight of steam required by the several types of engine in order to be able to make a reasonably close estimate of the size and style of engine to which the boiler will be best adapted.

The 65-horsepower boiler previously referred [illegible]

[illegible]

throttling engines, making some allowance for the possibility of the engine working beyond its rated power.

While this method of rating and proportioning boilers is in daily use and the results relied upon by those accustomed to using it, it cannot be said to be very convenient even for estimating because considerable data must first be obtained and if this cannot be done then certain quantities must be assumed and the value of the result will then be in keeping with the amount of practical experience possessed by the person makingg the calculations.

There is another method frequently employed by dealers for estimating the probable capacity of a boiler. While it is an improvement upon the method previously considered it may be well to call attention to one or two ways in which the results may be modified to suit the desire of the persons making the calculations. In these calculations the term horsepower is not necessarily employed, the capacity of the boiler being expressed in pounds, which refers to the probably evaporation from and at 212 degrees per hour. In order to determine the size or the horsepower of an engine a boiler of a given evaporative capacity is capable of supplying with steam, it is only necessary to divide the probable evaporation by the steam consumption of the particular engine or of the style of engine to be used. The average steam consumption of single-valve non-condensing engines is taken at about 30 pounds per horsepower hour; four-valve engines, 26 pounds; compound, 22 pounds. For condensing engines these figures are reduced about 15 per cent. An engine of 100 horsepower requiring 30 pounds of steam per horsepower hour will require a boiler capable of evaporating 3,000 pounds of water in the same length of time. This same boiler when supplying steam to an engine requiring 22 pounds will be capable of furnishing steam to an engine of $3,000 \div 22 = 137$ horsepower. It will be seen that by this method the horsepower of a boiler relative to the engine is obtained by dividing the capacity of the boiler expressed in pounds by the steam consumption of the engine per horsepower hour.

It has no doubt been noticed that the horsepower method of rating boilers, based upon the extent of heating surface only, does not take into account the fact that the probable capacity of a boiler, however it may be expressed, depends to a great extent upon the heat generated in the furnace, and this in turn depends upon the weight of fuel burned. It becomes necessary, therefore, even when making rough estimates, to take into account the necessary quantity of fuel to produce a given evaporation.

There are several formulas employed for making estimates of the probable capacity of boilers. The one more generally employed is $.0222\ R^2 + 9.56\ C =$ pounds of water evaporated from and at 212 degrees per hour for each square foot of grate surface, in which R represents the ratio of heating surface to grate surface and C the weight of coal burned per square foot of grate surface per hour. The ratio of heating to grate surface is found by dividing the area of the heating surface by the area of the grate surface, both expressed in square feet. To illustrate the application of the formula assume that a boiler contains 1,200 square feet of heating surface and 25 square feet of grate surface, and that 15 pounds of coal are to be burned on each square foot of grate. The probable evaporation is

$$.0222 \times \left(\frac{1,200}{25}\right)^2 + 9.56 \times 15)$$

$= 194.54$ pounds per hour for each square foot of grate and the total evaporation will be $194.54 \times 25 = 4,863.5$ pounds. This represents about the maximum evaporation that may be expected with hand firing under favorable conditions so that some margin should be allowed above the average requirements of the engine when selecting a boiler for one of given size and horsepower.

It will be noticed in the foregoing illustration that the apparent capacity of the boiler may be increased or decreased as desired, by simply changing the figures representing the weight of coal consumed per square foot of grate per hour. Had the weight of coal been 30 instead of 15 pounds the capacity would have been increased to 8,453.5 pounds per hour. To obtain this figure would be possible, but it is much higher than could be hoped for under anything less than extraordinary conditions. It is evident that it is a good plan to obtain some idea about the limit of the weight of coal that can be regularly burned per square foot of grate, before attempting to rate boilers in this manner. Without this information it is quite probable that an inexperienced person would be led to purchase a boiler much too small even with this method of determining the proper size.

When proportioning a boiler to an engine

or when ascertaining the capacity of a boiler of given size it is well to use a conservative figure representing the weight of coal burned per square foot of grate. Fourteen or fifteen pounds per square foot is high enough and should not be exceeded for hand fired boilers with natural draft, while 11 to 13 pounds will be found still better. It requires a strong draft and skilful firing and a fair grade of coal to be able to properly burn 20 pounds of coal and upward on each square foot of grate per hour. With forced draft this figure is frequently exceeded but it is not good policy to proportion a boiler so as to require this rate of combustion at the outstart.

An instance serving to illustrate the flexibility of the latter method of rating boilers is that of a mill in which two boilers were installed, supplying steam to a large automatic cut-off engine, two smaller engines for driving blowers, and for heating two large buildings with live steam. Each boiler contained 1,050 square feet of heating surface and 24 square feet of grate surface. The total weight of steam required per hour was approximately 10,500 pounds. The person who selected the boilers maintained that a rate of combustion of 24 pounds of coal per square foot represented good practice and consequently employed that figure in proving the capacity of the boilers ample for the work. Assuming the rate of combustion given above the capacity of each boiler is

$$.0222 \times \frac{(1050)^2}{24} - (9.56 \times 24) \times 24 = 6526.3 \text{ lbs.}$$

per hour, or 13,052.6 pounds for both boilers. The boilers were apparently ample in size and capacity, but when in actual service it was difficult to burn even 20 pounds of coal per square foot of grate owing to the changes in the intensity of the draft and inability to keep the grates free from clinkers. When forcing the fires to the utmost under the conditions existing it was found possible to carry the full load, but not without a considerable waste of fuel.

Attention is called to these two methods of estimating boiler capacity because they are very largely used by the majority of running engineers as well as other persons who, not possessing a practical knowledge of boilers and boiler practice rely implicitly on the results thus obtained.

The illustrations presented also emphasize *the fact that all* the data possible should be obtained when selecting a boiler for any purpose and that when information concerning the conditions cannot be obtained it is necessary to make a liberal provision for more or less unfavorable conditions that are very apt to be found when least expected.

Rope for Hoisting.

Mr. J. A. R. writes *Power*, this question:

"A weight of 4800 pounds is lifted by means of a rope and two blocks, each containing 3 pulleys, the friction is 30 per cent. What is the smallest size of hemp rope allowable? If the load is lifted 15 feet per minute, what is the horse-power expended?

The weight would be suspended by six ropes, as shown in the accompanying sketch, each rope supporting $4800 \div 6 = 800$ pounds.

Adding the friction the strain would be:

$$800 \times 1.30 = 1040 \text{ pounds.}$$

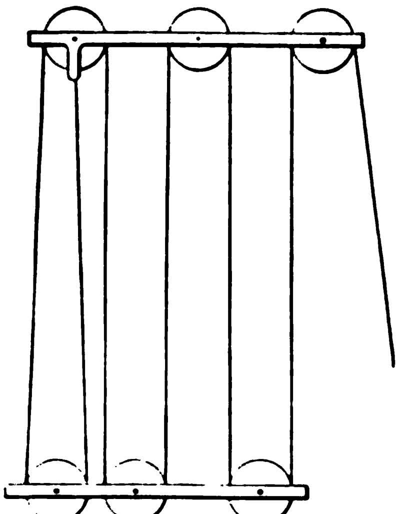
The smallest rope allowable depends upon the character of the service and how many chances one is willing to take. The following ultimate strengths are given by C. W. Hunt and T. Spencer Miller:

Diameter in Inches.	Ultimate Strength in Pounds.	
	Hunt.	Miller
3/4	3,640	4,150
13/16	4,500	5,030
[illegible]	5,440	5,970
1	6,480	7,020
1 1/16	7,600	8,160
1 1/8	8,820	9,370
1 [illegible]	10,120	10,690
1 [illegible]/16	11,500	12,000
1 [illegible]	13,000	13,500
1 [illegible]	14,600	14,900
1 [illegible]	16,200	16,500
1 [illegible]	18,000	18,100
1 [illegible]	21,800	21,500
2	25,900	25,200

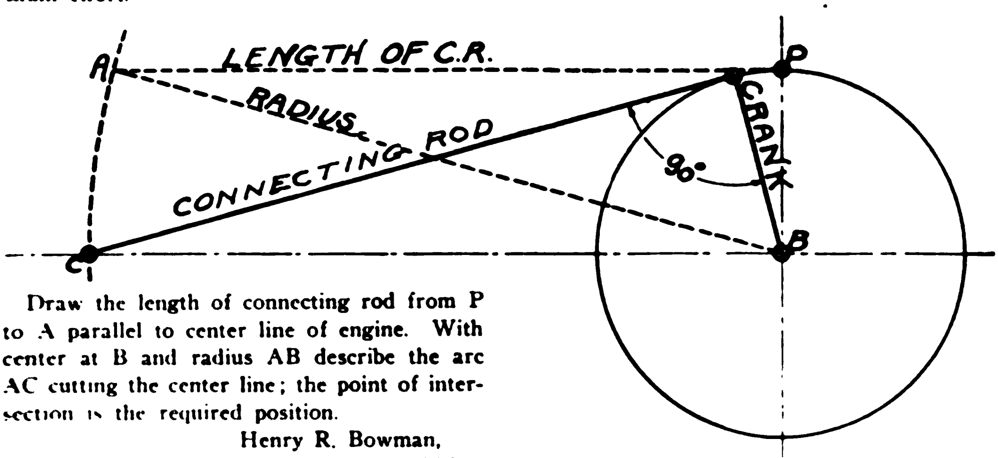
A one-inch rope would give a factor safety of between six and seven, but rope in running over the small sheaves of blocks chafes and grinds in the center with the bending, so that with continued service a liberal factor should be allowed.

A horse-power is 3300 foot pounds per minute. The horse-power required in this case would be:

$$\frac{4800 \times 15 \times 1.30}{33000} = 28.36^{\circ}.$$



To locate position of wrist-pin when crank and connecting rod are in position of maximum effort.



Draw the length of connecting rod from P to A parallel to center line of engine. With center at B and radius AB describe the arc AC cutting the center line; the point of intersection is the required position.

Henry R. Bowman,
Freeland, Balto. County, Md.

Some Queries.

(a) Will an injector feed water into a boiler above the water level: in other words, will it deliver into the steam space?

(b) If two boilers are set one above the other, will an injector take water from the lower one and feed it to the one above? Both boilers deliver to the same pipe, the pressure therefore being the same.

(c) What would be the steam pressure in a boiler if the temperature of the water therein was 662 degrees F. and 662 degrees C., respectively?

Ans.—(a) Cannot say, as we have never tried it **clined to, either.** Should think it would not work well for the following reasons: By so doing you would deluge your steam with water—a bad practice even if the water were at the same temperature as the steam, but still more so when, as in actual practice, it may be from 200 degrees to 250 degrees lower. When an engine is working hard and putting away a heavy drain on the boiler, there is a continual rush of steam to the stop valve from all parts of the steam space. If you injected into this space, you would get wet steam into your cylinders—a thing to avoid. Even putting aside the bad *results* of thus feeding your boiler, we think you would have a difficulty in actually doing it, arguing from the difficulty experienced by locomotive men in keeping their injectors at work when the water drops below the check, as it will sometimes do when swinging around a sharp curve just as the water happens to be low. (The water remains horizontal while the boiler tilts, thus uncovering the check on the high side, which usually causes the injector to "break.")

(b) We think it would not work because the water, being at the same temperature as the steam, would not condense it. It seems unnecessary to look for any other objections.

(c) This is an idle question, particularly the last part. However, applying Regnault's theory, we find the absolute pressure to be 2,277 and 22,790 lb. per sq. in respectively. Many comments suggest themselves, to indulge which would be a waste of space.

(a) An injector will raise water 28 feet, but will it raise water regularly 30 feet? If so, will it also force the water into a boiler

having a pressure of 100 lb. per square inch?

(b) How far will a double acting steam pump raise water?

Ans.—(a) It is extremely doubtful that the injector would raise the water 30 feet.

(b) The theoretical or maximum height in feet that any pump can raise water in the given locality can always be found by multiplying the height of the barometer at the place by 1.133. Thus, if in a certain place the barometer stands at 26 inches, the maximum height is $26 \times 1.133 = 29.46$ feet. The distance that a pump will actually raise water, depends upon the condition, but will always be less than the theoretical distance.

Hoisting Facilities in Sub-stations.

MANY railway sub-stations are very deficient in hoisting facilities, and whenever it becomes necessary to remove transformers or rotary converter armatures for the purpose of repairs at the factory no little difficulty is encountered. Without some sort of permanent hoisting facilities it is difficult to move a 500-k. w. transformer weighing some 6 or 7 tons, and even a 200-k. w. unit, weighing over 3 tons, requires not a little skillful handling for expeditious work.

Few engineers would recommend the installation of power-driven hoists in any sub-stations of ordinary size, as the occasion for their use are few and far between. Possibly a motor-driven crane is desirable in connection with installations of 10,000 or 15,000 k. w. capacity and larger, as the cost of a moderate-speed crane complete is very small as compared with the entire sub-station cost, and a power-driven hoist is certainly a great convenience. There appears to be no good reason, however, why a chain hoist of the hand-operated type should not form a part of the equipment of every substation.

Steam High-Priced Here.

THE Furnace Creek Copper Company on the side of Death Valley, California, has installed a complete hoisting plant, operated by a gasoline engine. The mine is known as the Copper Blue, and the shaft has already been sunk 100 feet. It is the intention of the company to put the shaft down 500 feet and to crosscut at the 250 foot level.

This is another instance where the practical utility of the gasoline engine is demonstrated in mining operations. The price of coal is so high in that section of the country as to practically prohibit the use of the steam engine, and while the cost of gasoline is higher than in the East and Middle West, still the fuel cost of operation is but a minimum as compared with coal.

A Springfield, O., concern has introduced a motor sleigh, which they claim has carried 27 people 10 miles an hour through the snow.

The wages paid in India for mining coal—22 cents a ton—ought to make that a profitable undertaking to the operators. Women are employed as laborers about the mines. Both the wages paid the men and the employment of women are discreditable.

The time taken to insert an ordinary hand shovel into a pile of coal, ore, or other similar material is shorter if it is shoved into the top instead of the bottom of a pile. It also varies with materials, taking longer for coke than sand. The size and shape of the shovel also affects the speed of the operation, for different sizes and shapes of shovels are better adapted to different materials.

The original or true babbitt metal was patented by Isaac Babbitt of Boston, in 1839; it contains 24 parts tin, 4 parts copper and 8 antimony. A tougher metal is made of tin, 96 parts, copper 4 and antimony 8 parts. Lead is also added in some cases on account of its cheapness. In small amounts it is not objectionable, but the metal sold in the market ready mixed usually contains more lead than its price would indicate.—*Ex.*

Flat steel ropes from present outlook are not likely to supersede the round steel rope for hoisting purposes. The first cost of the flat rope is greater, it wears faster, weighs more and is harder to repair. The advantage of the flat rope is that it prevents fleeting, and that it is generally built to taper, so that the smallest end is at the cage, when the load is least. Also when the rope is out and the cage at the bottom of the shaft, giving the maximum load to be hoisted, the drum, or rather reel, is of a minimum diameter, and the engine has its greatest leverage to start the load, thus increasing the mechanical efficiency.

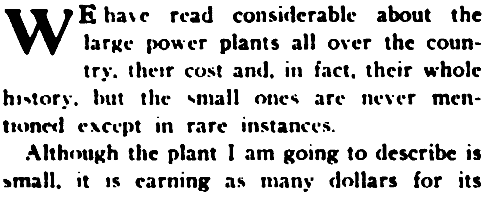
ENGINEERING REVIEW.

Cost of a 35-Horse Power Plant.

WE have read considerable about the large power plants all over the country, their cost and, in fact, their whole history, but the small ones are never mentioned except in rare instances.

Although the plant I am going to describe is small, it is earning as many dollars for its owners on the investment as the large plant is doing. The power is all obtained from a 10 x 15-inch cylinder, center-crank engine and a portable firebox boiler, both rated at 35-horsepower. As the engine and boiler have some attention given to them occasionally, they are holding up to more than their rated capacity.

The fuel used is natural gas, and the burners are of the type described in the December issue, 1904. The engine makes 166 revolutions per minute and is belted to the conveyors as shown by the illustration. The plant is running what some people called a low down business, viz., a brick plant.



ENGINE AND CLAY ELEVATORS.

The machinery used in this kind of business pulls hard and requires constant watching and care to make things pleasant as well as profitable to all concerned.

As will be seen by the sketch, the engine has two pulleys, one on each side. One is 30 inches in diameter with a 12-inch face; the other is 60 inches in diameter and has a 14-inch face. Both are of cast iron and are well made. The smaller pulley drives what is called a dry-pan, 8 feet in diameter. This pan grinds all the clay that is used for making a first-class building brick. It is capable of grinding or pulverizing enough tough clay in 10 hours to make 35,000 standard size bricks. The ground material falls into No. 1 elevator and is drawn up and falls by gravity on a stationary screen, the fine material passing to the brick machine or stock bin at the will of the operator, the coarse grains all falling back into the pan to be ground over again.

The second elevator No. 2, elevates the ground material either direct into the brick-machine, or to the stock bin, which has a capacity for about 40,000 brick. The material falls out of the bin into the machine by gravity.

The clay is brought up out of the clay pit by means of a jack, a wire rope and two cars; the bottom of the pit is 18 feet lower than the center of the jack and 90 feet of ½-inch wire rope is required to reach out the required length between the pit and the jack. Power is taken as shown with exactly 62 inches between centers, an 8-inch 4-ply rubber belt being used. As the rest of the illustration is self explanatory I will give the cost of the outfit.

The boiler and engine cost $745; pan, $600; brick machine, $725; Marsh pump, $64; belting all complete, $254; building 40 x 90 feet, $315; all pulleys outside of those that came with the engine, pan, and machine, $53. The tank was delivered here for $32. All pipe for steam, water, and gas, was bought at one time and ranges in size from ¼ to 6-inch, together with a set of cutting and threading tools from ¼ to 2-inch complete f. o. b. here for $283.40. Total, $3,072.20.

The cost of installing, including five barrels of cement, 9,000 hard brick, digging foundations, laying the brick, and all labor from the time the machinery arrived until ready to run, was $127.75. Incidentals, $44.60. Total, $3,144.55.

Last season there were made here 600,000 brick, the repair bill was about 3 cents per thousand, and the waste about 5 per cent. This plant is what is termed a "summer resort," that is, it does not operate in the winter months, but averages seven months in the

year, or about 20 days a month, and makes about 1,540,000 brick in one season. At $6.50 per thousand, less 5 per cent for breakage, etc., and 3 cents a thousand for general repairs, leaves as clear profit $9,886.80 for one season's run, which is not so bad for a small plant.

I have never had the proper and necessary appliances to figure out the cost of gas per horsepower at the boiler, but I have timed the meter, and between 11,000 and 12,000 cubic feet of gas a day will run the power plant end of it. Gas costs 6 cents per thousand feet here.—F. C. H., in *Engineer's Review.*

Growth of Municipal Electric Lighting.

WITH municipal ownership problems occupying so large a share of the public attention, the statistics on the municipal ownership of electric light plants recently compiled by Edward Bradford Smith for the legislative reference department of the Wisconsin Free Library Commission are of special interest. Mr. Smith is a graduate of the University of Wisconsin, in the class of 1897, and during the past year he has been research scholar in political science in the University. His study of the electric light problem was made in direct response to a flood of letters which have been received by the legislative reference department from city officials and legislators, asking "What cities have municipal electric light plants?" "How many exist in Wisconsin?" "How many are there in America?" Similar questions are being asked with regard to gas plants, and the department will soon be able to furnish full information on that subject also.

MUNICIPAL LIGHTING IN WISCONSIN

The first municipal electric light plant in Wisconsin was established at Bayfield in 1886, five years after the beginning of the electric lighting business in this State. At that time there were 30 private plants in operation. The latest figures, those of last March, show 46 municipal and 12[illegible] private plants in the State, indicating a growth of municipal ownership in the past seventeen years from one-thirtieth to one-third of all the plants in the State. Of the 12[illegible] private plants 58 are in places of less than 1,000 population, which is true, also, of 13 of the 46 municipal plants. Eleven towns have the municipal electric light plant operated in connection with the municipal water works. Only one plant, that in Hudson, is leased to a private company.

OTHER STATES AND ABROAD

The strength of the municipal ownership movement is in the cities of from 1000 to 10,000 inhabitants. Wisconsin is one of the twenty-four States of the Union which have no cities of over 10,000 population with municipal electric plants. In the past twenty-five years the number of municipally owned electric light plants has increased from 1 to 1050, and the number of private plants from 7 to 3234; that is, in 1881 the municipal plants were nearly ten per cent. of the whole number of plants, while in 1905 the municipal percentage had risen to over twenty-four. This is materially increased in the six months of 1906 now elapsed. During the last twenty-five years, too, 13 plants have changed from municipal to private ownership, but the balance was more than made good by the change of over 170 private plants to municipal ownership. Among these latter were the plants of nine Wisconsin cities, Oconomowoc, Bayfield, Cedarburg, Florence, Fort Atkinson, Jefferson, New Richmond, Plymouth and Two Rivers.

Canada has 80 municipal electric light plants, and in England about two-thirds of the electric light plants are owned by municipalities. In the entire United Kingdom there are 281 municipal plants and 2[illegible] private [illegible]. —*American Machinist.*

The Government's Success in Dredging at Ambrose Channel.

A RECENT report made by Mr. Henry N. Babcock, to Col. W. L. Marshall, Corps of Engineers, U. S. A., and reviewed by the *Engineering Record*, sets forth the experience which has been gained with two government dredges, operating at Ambrose Channel at the entrance to the harbor of New York, as to their rate of working, the cost of dredging, manner of working, and other features both of construction and operation of the two machines.

The dredges, which are self-contained, seagoing vessels, holding there own dredged material until dumped in deep water, each have a carrying capacity of about 2,400 cubic yards. The dredging pumps are of the centrifugal type, and the pumping is done while the vessel

is in motion at a speed of a mile or a mile and a half per hour against the current, and three or four miles per hour with the current.

During the eleven months ending May 31st, the quantity removed was a little over three and a quarter million cubic yards at an actual floating cost (including miscellaneous supplies, repairs, and renewals) of 5.274 cents per cubic yard. About two-thirds of this cost is chargeable to pumping.

The next item of expense, a little more than one-seventh of the total cost, is the cost of going to the dump; returning from the dump is about one-eighth of the total cost.

While large quantities of soft material are excavated and transported hydraulically in other localities under more favorable conditions, at much less cost, these sea-working dredges are fully justifying their construction. The results have a significance beyond their association with harbor work, and indicate the efficiency and economical use of hydraulic excavation, transportation, and disposition of material in the building of dams and other similar structures which have already found a number of important applications.

Long Distance Power.

The Victoria Falls Scheme May Not Prove a Success.

The Financial Times, of London, asserts through Victor M. Braschi and Co., of the that views obtained from various experts on the Rand, in Africa, concerning the Victoria Falls power scheme, show that it will not be a financial success.

In the immediate vicinity of the Rand coal is both cheap and abundant, and water for condensing purposes can be obtained in practically unlimited quantities within 40 miles of Johannesburg. Where coal is dear and water is scarce there is no question about the success of a cheap water-power installation, and this accounts for the success of such enormous undertakings as the Mexican Light and Power Corporation with an issued capital of $30,000,000, coal being unobtainable in Mexico City under about $7.50 per ton, and for the desire to operate by water power electric tramways and lighting plants in all the larger centers of South America where coal is equally dear. On the other hand, with unlimited coal at a low price and with modern electrical appliances, it is said to be very questionable whether the Victoria Falls can transmit power to the Rand in selling competition with that to be derived from such cheap coal. The longest transmission line at present working is said to be less than 200 miles, carrying an effective load of under 40,000 horsepower. The long distance from the falls to the Rand will interfere, the *Times* says, with the success of the movement.

The "Closed Shop" in Schools.

ANOTHER surprise, another shock, comes from Philadelphia, of late a storm center of preposterous practices in the business world. Now it is organized labor seriously proposing to unionize the public schools of that town, to create a mighty "closed shop" in the educational system of the City of Brotherly Love, the organization to include both the teachers and the taught.

The Philadelphia Board of Education has dared to arrange for the establishment of trades shools as an adjunct to the regular public school system, these institutions to be formally opened this week. In view of the unfair restrictions placed by the unions on apprenticeships in practically all the trades—a system that is fast closing the doors of getting-a-living against intelligent, ambitious boys and girls all over the United States—the educational authorities of that city are instituting an educational reform whose wisdom, practicability and philanthropy are self-demonstrating. But along comes the Central Labor Union, the power in the organized trades there, with a loud protest at this infringement of labor's vested rights! Its delegates declared at last Sunday's meeting that these trade shools will prove a mere nursery for "scabs" and that the young men graduated from them after a three years' course would be inimical to the unions. Their work and influence must be offset forthwith, or free, intelligent, skilled, un-bossed labor will soon menace the very existence of unionism! To prevent such a calamity this scheme is proposed by the organized labor powers in Philadelphia:

To organize all the public school teachers at once; all "scab" teachers having thus been excluded from the schools, the union educators to begin the work of instilling into the youthful mind the "principles" of trades un-

ionism; the children—under compulsory rules—to wear at school the union buttons of their fathers' crafts; the "scab" child to have brought home to him the force of unionism, even to the point of expulsion; and these educators paid from the public treasury to give regular lessons on the evils of the open shop as a part of the school curriculum. "Most of the teachers are women and too high-toned, maybe, to associate with workingmen, but they'll come around," delared one delegate.

And they unquestionably would "come around" in due time when they saw their bread and butter fading away from them under the blight of unionism. This scheme is no idle dream. Unionism is capable of carrying it out, if left with a free hand to pursue its insidious tactics. It may have begun the vicious work already, not only in Philadelphia but right here in New York also and in every populous city where its organizers sense the popular protest against the menace to industry and the public welfare in general that lies in the present restrictions on apprenticeship. No proposer, advocate or even tacit supporter of such a preposterous plan should be voted into a board of education or a legislative body anywhere; much less should the application of a teacher holding such views be given consideration. Free public schools are the great bulwark of our liberties here in the United States. Whoever strikes a blow at them is as much a traitor as he who tears down the Stars and Stripes.

The people have the prevention of this bit of labor treason in their own hands.—*New York Commericial.*

Government Tests of Spokes.

DURING the past few months the Forest Service division of the Department of Agriculture has been conducting a series of tests on vehicle woods, the tests being made on three manufactured parts, spokes, wagon poles and axles. The tests on spokes are of much interest to the automobile world. Material was furnished by wagon companies and wheel manufacturers, and the tests conducted at the timber-testing station of the Forest Service at Purdue University, Lafayette, Indiana. One series of these tests has been completed, but all of the data is not yet ready for publication.

The material tested was of the grades in common use. Buggy spokes were of the grades A, B, C, D, E, and culls, for the sarven wheel. In this selection, the primary object was to determine whether the grading system was compatible with the strength and toughness of the spokes and also to ascertain the relative strength and toughness of white and red hickory spokes. Five hundred spokes constituted the series. The poles were of two grades of oak and one grade of southern pine. Part of the common oak poles were trussed. Forty poles were tested. The axles were of hickory and maple of three designs, thimble, skein, thimble-skein trussed, and long-sleeve-skein trussed. There were eight axles of each species and each design, making forty-eight in all. The object in this series was to obtain the comparative strength of the two woods and of the different constructions.

The results from the spoke test show more than 50 per cent. error in the present grading system, which is largely due to the traditional prejudice and consequent discrimination against red hickory. No red spokes are now allowed in the A and B grades, yet these tests show that a large proportion of the red spokes now included in the lower grades should be, because of their strength and toughness, included in the highest grades. The resilience factor, which is determined by maximum load and toughness, varies directly with the weight, showing that the best criterion for judging the utility of spokes is the weight. It is also shown by the tests that, weight for weight, the red and mixed spokes are fully as strong as the white ones. Of defects serious enough to affect the strength, those near the center of the spokes are considerably more damaging than the defects near the ends. A study of the tested spokes as they now appear at the Purdue University laboratory would give practical information to commercial graders. These tests will be supplemented by another series on spokes manufactured of sound dead hickory, which occurs in considerable quantity in the South and is not now used for this purpose.—*Automobile.*

How Is This for Progress?

THE Earl of Chatham said about 150 years ago that the American Colonists had no right to manufacture so much as a horse nail.

In 1750 law forbad in America the erection of an iron rolling mill.

In 1780 even Be ly

foresighted, said America will not make manufactures enough for her own consumption in 1000 years.

Sir Charles Napier said he would not command a steam propelled navy, as he didn't want to be boiled alive.

Lord Stanley said if steamships cross the Atlantic I will eat the boiler of the first boat that arrives.

Sir Humphrey Davy said it was as reasonable to talk of ventilating London with windmills as to light the big city with gas.

When Fulton's first steamer went up the Hudson the date was the 17th of August and the preachers of the time cursed the boat on the ground that the date was the total of the ten horns and the seven heads of the beast of Apocalypse.

As late as 1830 instruction in natural science was only to be had in colleges designed exclusively to train professional men.

By 1830 John Fitch, Oliver Evans and Robert Fulton had demonstrated the function of steam for land and water travel.

Whittemore had started his carving machine and Morse the electric telegraph. One year Harvard graduated only seven, whereas in 1906 she conferred 1073 degrees.

Today the American crops total a value of $5,000,000,000, and after supplying our own 90,000,000 with manufactured goods we have left over $400,000,000 for export.

A clever machine is now ready to accomplish every mechanical detail.

Horse-power costs only 1-3 of the coal it cost thirty years ago. In 1814 Daniel Webster said: "I am not in haste to see Sheffield and Birmingham in America" and in 1906 America has one corporation doing as much business as either the whole of Sheffield or Birmingham.—J. A. WALKER, *in Graphite*.

Metallics.

A MIXTURE of copper containing 2 1/3 per cent of silicon may be readily drawn into wire or rolled into sheets and excellent spring metal has been made from it.

Iridium is one of the non-ferrous metals which rival steel in hardness, and there are many instances in which it could be used where a hard, non-corrosive metal is necessary.

A brass mixture which has nearly the same coefficient [illegible] contraction as [illegible] 88 parts of copper, 10 parts of tin, and 2 parts of zinc.

Cupro-nickel is an alloy composed of copper and nickel and is used for covering the bullet of the cartridges used by the United States and other governments. The covering is called a "bullet-jacket." Cupro-nickel is composed of copper 8 per cent and nickel 20 per cent. There is also a lower grade used which contains only 15 per cent of nickel. These alloys contain no zinc. The alloy, in slightly different proportions, is also used for the blades of some makes of steam turbines.

"Aluminum gold" is an alloy of 96 per cent of copper and 4 per cent of aluminum. The color of this alloy is the nearest approach to 14-karat gold that is known. The large amount of copper unfits it for any place where a non-corrosive alloy is required, but as far as color is concerned it cannot be surpassed.

Silicon-copper of proper proportions makes an excellent spring metal. The alloys of copper and silicon may be rolled into sheet or drawn into wire, if the silicon content does not exceed 4 per cent. The alloys between 3 and 4 per cent, however, are almost too hard to draw into wire and a lower percentage is preferable.

Leaded brass chips are known by their short or brittle appearance where fractured. The lead imparts to the brass a quality which allows the chip to break off under the action of the cutting tool. It does not produce long, fibrous shavings like those which are formed from brass free from lead. Lead imparts a free cutting quality to brass and a short, brittle chip is the result. Leaded brass chips may be detected by their appearance, and it is rare that one actually sees any other kind.

A mixture of two-thirds pine tar and one-third linseed oil is a good coating, or rather preservative for wire ropes running underground or in water. It is not strictly necessary to boil the tar, though preferable. This is the mixture used by most cable roads.

W. G. Crosthwaite, of Leeds (British patent 20,842, September 28, 1904), states that a valuable alloy for making firebars is obtained by adding aluminum to molten pig iron, and then steel borings; the proportions used being preferably 100 parts of pig iron to one part of aluminum and five parts of steel, by weight. The alloy when formed may be cast into firebars in the usual way.—*Ideal Power*.

In riveting with pneumatic hammers, two men and one heater averaged 500 rivets in 10

hours; whereas by hand 250 rivets was a good day's work for three men and one heater. The cost per rivet was 1.62c by pneumatic hammer, and 3.68c by hand. On 93,480 rivets in a shipyard at Chicago, the machine cost was 1 to 2.5c, according to size; the hand cost, 2.5 to 4.5c. On 1,300,000 rivets at Cramps' shipyard, near Philadelphia, the hand price was 7c for 1-inch; machine, 3c. For ⅞-inch the hand cost was 5.5c; machine cost, 3c. In general, riveting with the pneumatic hammer is 40 to 50 per cent of the cost by hand.

Prevention of Rust.

AS the time draws near for our annual convention I look forward with pleasant anticipations in meeting so many old acquaintances and listening to the many reports of the several committees on different subjects connected with our business. I always learn something beneficial to all who have any pride in the matter of painting railroad equipment.

I suppose the old and familiar subject of iron rust will be threshed out again as usual; and this reminds me of something in that line that was quite new to me and may be of interest to some others. It has always been the accepted theory that iron rust was caused by moisture and oxygen, but by some recent tests this theory has been knocked all into "smithereens," and it has been proved that carbonic acid is the sole cause of iron rusting. Oxygen and water play no part in the business.

A piece of polished iron was exposed to distilled water and a continued current of air freed from carbonic acid, and the metal continued untarnished at the end of six weeks; when air with the normal carbonic acid was drawn over the sample, however, the bright surface was dulled in six hours, and was covered with a deep red rust in seventy-two hours, which proves very conclusively that we have been on the wrong track and that oxygen and moisture play no part in iron rusting.

What is up to us now is to find something to check the action of carbonic acid, which, no doubt, some thinking mind will accomplish. Rust and rot are forms of disease and decay in metal and wood and the chemists and painters are the doctors and nurses who can arrest their progress if not prevent them altogether when cars and engines are brought to the paint shops, which are the hospitals. Cancer in the human body is rarely, if ever cured, because it is in the blood and system to such an extent that it is next to impossibe to eradicate it. Unlike this, decay in metals and wood, of which railroad rolling stock and buildings and bridges are constructed, is wholly from the elements without and if they can be thoroughly protected from these there is no reason why they should not last indefinitely, or until actual wear and tear displaces them. It is useless to say it cannot be done, just because many failures have been met with with bogus material and the whole painting business condemned indiscriminately. It can be done. Give the intelligent unprejudiced painters a fair show in their choice of methods and materials and watch and wait for results and some surprise may be met with in comparison with former experiences.—WARNER BAILEY, in *Railway Master Mechanic*.

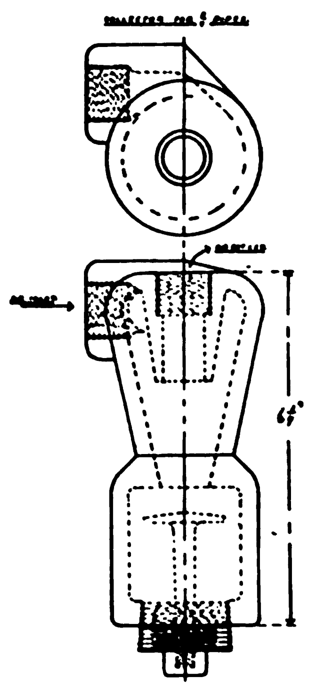
An Air Purifier.

A TROUBLESOME feature in the operation of air brakes, and, in fact, all pneumatic devices, is the presence of dirt and moisture in the air. Dirt proves most troublesome around triple valves on automatic air brakes systems, where it may prevent the operation of the brakes. Moisture is a common cause of trouble during freezing weather around valves and moving parts in all kinds of compressed air apparatus. Large drums are sometimes used in the pipe lines, so that the moisture and dust will have time to settle. Drums for this purpose are valuable only when the velocity of the air through them is very low. Screens in the pipes strain the air and catch all the particles that cannot get through the mesh of the screen, in time clogging up the screen, yet letting small particles through.

A device which has been remarkably successful in keeping dirt out of triple valves on automatic air brake equipments on steam railways has recently been specified for use in connection with the electro-pneumatic multiple-unit control system on the new cars now being built for the Metropolitan West Side Elevated Railway, Chicago. A sectional drawing of this device is shown herewith. It consists of two chambers, an upper or separation chamber, and a lower or settling chamber. The air inlet which is at the top of the separating chamber is so designed that the entering air takes up a whirling motion around the walls of the chamber. The solid matter, such as dirt and moisture, is then

thrown by centrifugal force against the outer walls of the chamber, while purified air passes up through the opening in the center. The impurities fall into the settling chamber below.

The outlet for the air is in the axis of the vortex of air in the chamber, consequently nothing but pure air is drawn into the outlet. The principle is one which has been employed successfully for many years in dust and shavings collectors in planing mills, to prevent the impurities in the lower chamber



OUTLINE AND TOP PLAN OF AIR PURIFIER

being drawn up by vortex after they have settled; the pedestal of cap shown in the drawing is used. The accumulation of dirt in the collecting chamber is removed without difficulty by unscrewing the plug at the bottom. Where there is much moisture a pet cock can be placed at this point.

An efficiency of 100 per cent is claimed for the device, based on tests in which a known weight of water and dust was introduced in the supply pipe and the amount accumulated in the collecting chamber weighed after passing through the separator.

The test — t practically all the foreign matter is removed from the air. The device should preferably be inserted in piping system as near to the apparatus to be protected as possible. An automatic air-brake system it is located at the inlet to the triple valve. Previous devices to free the air of impurities have employed screens or packing, which partially obstruct the passage, and as dirt and moisture accumulate, the passage is obstructed still more, until finally the supply may be completely shut off. The device under description depends upon centrifugal force for its action, and does not in any way obstruct the passage. The accumulation of dirt and moisture in the triple valve of automatic air-brake systems requires them to be cleaned on passenger cars every three months on some roads, and at least every six months, to comply with M. C. B. requirements. Double that period is allowable on freight equipments. The length of time that a triple valve will operate is dependent upon the accumulated dirt. By keeping out the dirt, the length of time it will operate without attention will depend upon the lubrication and the fitting of the parts. This collector is being put on the market by the Derby Mfg. Company of Burlington, Iowa. —*Street Railway Journal.*

Preservation of Wood.

THE artificial treatment of timber to guard against decay may be briefly described as the introduction into the pores of some poison or antiseptic to prevent the germination of the spores. Such treatment is efficacious as long as the substance introduced remains in the wood. Creosote is the best of preservations and the only one effective against sea worms, but is expensive.

The timber is placed in a closed tank and steam is admitted to soften the cells. After some time the steam is shut off, a partial vacuum is formed and the preservation fluid is run in and pressure applied to force all the liquid into the pores of the wood. As steaming injures the fibres, treated timber is weaker than untreated.

Burnettizing is the name given to treatment with zinc chloride, a comparatively cheap process applied to railway ties and paving blocks. To prevent the zinc chloride from dissolving out in wet situations, tannin has been added after the zinc, to form with the vegetable albumen a sort of artificial leather, plugging up the pores; hence the name, zinc tannin process.

For bridge timbers, burnettizing makes the timber unduly brittle.

As the outside of treated timber contains most of the preservative, timber should be framed before being treated.

Fly-Wheel Wrecks—Safety Device Fallacies.

BY WM. H. BOEHM.*

EVERY stationary engine is equipped with some sort of a speed-governing device. The governor is usually made by the builder of the engine and is considered a part of the engine. The object of the governor is to maintain the speed of the engine nearly constant at some agreed number of revolutions per minute.

There is always a slight variation in the agreed speed because a change in speed is required to actuate the governing mechanism. The change in speed required to actuate a good governor is usually about two per cent.

A fluctuation in speed of only two per cent is immaterial so far as the safety of the fly-wheel is concerned. Inasmuch, however, as the load on most engines is varying continually, the governor is working continually to keep the speed nearly constant. As no mechanism can be expected to work day in and day out without sooner or later getting out of order, fly-wheel explosions are all too frequent in occurrence.

So many disastrous fly-wheel wrecks have been caused by governor accidents that the market has been flooded with innumerable safety devices. Nearly all of them are designed with the idea that an accident to any part of the governing mechanism will actuate the safety so as to shut off the steam and stop the engine. The breakage of governor belts is, for example, so frequent a cause of fly wheel wrecks that every engine is nowadays equipped by its builder with some device that is expected to shut off the steam when the governor belt breaks. None of these devices can be depended upon, however, and some are worse than useless.

Take, for example, the safety in use today on practically every Corliss engine running in the land. It is designed under the supposition that when the governor belt breaks, the balls will suddenly drop to their lowest position, trip the cut-off and shut off the steam. This *device is wrong* in principle. Anyone who has ever spun tops knows that a top continues to revolve after it is clear of the string, and that a considerable length of time elapses before the top dies down.

Now the fly-ball governor on a Corliss engine is a top in principle. The balls are spun about on a vertical spindle that is nearly frictionless. The governor belt is the string to this top. When it breaks the balls do not fall suddenly; they continue to revolve, dying down slowly as in the case of the top. And while the governor is dying down, the balls are moving inward, admitting more and more steam and allowing the speed to become faster and faster until the fly-wheel is burst by centrifugal force.

It may be argued that the mechanism should be arranged so as to trip the cut-off before the speed becomes dangerous. So it should and it generally is when it leaves the engine builder's shop. But when the engine, under a fluctuating load, shuts down several times during the same day, upsetting each time the factory routine and bringing about innumerable complaints of service, almost any engineer will either set the safety cams back or block the governor so as to render the safety device inoperative.

Engine inspectors have reported innumerable instances where the safety cams have been deliberately removed and either lost or thrown away. Several instances have been reported where an inspector after ordering a block removed from a governor, returned in ten minutes to find the block in place again. Why any engineer should risk the destruction of his own life and his employer's property by a practice so dangerous, is almost beyond understanding. We know, however, that he is at times almost forced to take such risks in order to avoid censure for interruption of service.

The failure of the regular safety devices to prevent fly-wheel wrecks has prompted the invention of special safety devices designed to act independent of the regular device. These special devices lessen the chances of accident somewhat, but they cannot be depended upon because they consist of complicated mechanism as easy to get out of order as any other mechanism about the engine.

Many fly-wheel wrecks are precipitated by the breakage of the main driving belt of the engine. These belts are heavy and run at a speed approximating a mile a minute. When they break they are hurled with terrific force upon the governor and safety de-

them both out of commission. The engine, then free of its load and receiving steam at full boiler pressure, races and bursts the wheel by centrifugal force.

The fly-wheel wreck which recently occurred at the power house of the Mansfield Railway Light & Power Company, and which was illustrated on page 379 of June number of *Power*, was a case of this kind. The engine was equipped with the best known special safety device on the market. It was the only engine of four in the plant equipped with this device. When the main driving belt broke it was hurled upon the governor and safety device. The governor was wrecked, and the sprocket chain through which the safety device was expected to close the throttle valve was broken in two.—*Power*.

Labor Being Better Paid.

THE census bureau has completed its compilation of statistics on the manufacturing industries of the entire country, showing that the total invested is $12,686,265,673, an increase of 41.3 per cent over 1900.

The number of establishments is 216,262, an increase of 4.2 per cent.

The aggregate amount of wages paid in 1905 was $2,611,540,532, an increase of 29.8 per cent. The fact that there were only 15.9 per cent more laborers employed in 1905 than in 1900 shows that there was a considerable increase in wages earned.

Extruded Metal.

EXTRUDED metal is made by forcing hot metal through a die by means of hydraulic pressure. The linotype machine is an analagous type. The shape of the die determines the shape of the extruded metal. The manufacture of extruded metal is confined to mixtures which will work hot, as the operation must be carried on while the metal is red-hot. For this reason common brass cannot be extruded, as it is not malleable at a red heat. A mixture of 55 per cent copper and 45 per cent zinc is soft while hot and hard and stiff while cold, so that it is admirably adapted for extrusion. The mixture cannot be cast in sand without the addition of aluminum and the following proportions are recommended for this purpose: Copper, 55 pounds; zinc, 45 pounds; aluminum, 4 ounce. A mixture that will [illegible] can be made by adding 2 pounds of lead to the above mixture.

Pumping Machinery in China.

Consul-General Jas. L. Rodgers supplies information from Shanghai as to the market in China for pumping machinery, as follows:

While the demand for steam pumps and hydraulic machinery is not now much in evidence, it will probably develop slowly along with other lines, the Chinese of late having exhibited great interest in all classes of machinery. However, with cheap labor and the peculiar and crude but very effective Chinese pumps, it may be expected that the use of such modern devices for a long time will be confined almost exclusively to cities. The water wheel, turned by the buffalo, can hardly be supplanted for irrigation work, and it is hard to imagine any other use to which a steam pump could be put in the country districts under the present economy of the people.

Liquid Air.

Manufactured Successfully in France.

CONSUL BRUNOT, of Saint-Etienne, writes that a group of savants of the Academie des Sciences, Paris, very recently paid a visit to a factory at Boulogne-sur-Seine, to witness the manufacture for industrial purposes of enormous quantities of oxygen and nitrogen, extracted in a liquid state from atmospheric air. The consul says:

Georges Claude, the inventor of the interesting process, furnished the explanations. As the liquid oxygen flowed out from the generator it was of a blueish hue, while the nitrogen was colorless. Several experiments were made for the visitors to prove the importance of having an abundant supply of oxygen at one's disposal; a forge set up in the grounds showed the wonderful effects of the gas. The fire, which had almost died out, was immediately rendered incandescent by a current of hydroxide from the blowpipe. A bar of iron was brought to a red heat and then melted like lead. Two pieces of iron were welded in a few minutes by the aid of a powerful flame from the blowpipe. Much costly and tedious riveting will be no longer necessary; iron will be welded against iron, copper against copper, etc. The doctors already foresee the possible treatment with liquid

air of certain affections of microbian origin, such as osteomyelitis, anthrax, and the malignant disease of the skin termed lupus.

Liquid air has been tried in mines as an explosive agent, and for this purpose marl is wet with petroleum and then saturated with liquid air. The paste thus formed constitutes a good explosive when fired with fulminate, and has the advantage, when it hangs fire, to be without danger, as the liquid air evaporates very rapidly.

The price of oxygen, according to M. Claude, for industrial purposes will not exceed 4 to 6 mills per cubic meter. Will it be possible to use liquid air as a motor power? The idea is very tempting and will be studied. It would be in any case particularly applicable to submarine boats, balloons, automobiles, etc. For the present it is sufficient to say that the invention of Georges Claude is quite recent, and that the easy and practical production of liquid air has only just been realized. Consequently, it may be expected with every confidence, in this century of rapidly advancing progress, that the dreams of today may be the realities of tomorrow.

Consul Brunot furnishes a complete description of the methods used in this invention, with a drawing, copies of which will be furnished to scientific journals on application to the Bureau of Manufacturers.

Vanadium Steel.

CONSUL MARSHAL HALSTEAD, of Birmingham, reports that in a paper on vanadium steel making, contributed by Mr. J. Kent Smith to the Liverpool section of the Society of Chemical Industry at a recent meeting, the author stated:

"Messrs. Willans and Robinson were now producing special vanadium steel alloys at the rate of 800 tons per annum at their Queensferry works. The ferrovanadium used for the manufacture of these special alloys was obtained from the Llanelly works of the New Vanadium Alloys Company, in South Wales, and contained up to 30 per cent of vanadium. The chrome-vanadium steels were those which showed the most remarkable properties, and these contained from 10 to 20 per cent vanadium. The vanadium steel industry is altogether an English industry, 80 per cent of the production being now taken by the motor car and motor omnibus manufacturers of this country. In one case 150 axles of chrome-vanadium steel were ordered and are now running with satisfactory results, and the firm in question has given a repeat order for 400 axles of the same alloy. Chrome-vanadium steel has also been exported to France, although an import duty of £5 per ton has to be paid upon it.

"The effect of vanadium upon ternary and quaternary steels is to increase the resistance to both static and dynamic tests, a result which is partly due, in the opinion of Mr. Kent Smith, to the action of the metal in retarding the segregation of the cerbides during cooling. The highest test yet obtained from a chrome-vanadium steel, after special heat treatment, was a maximum breaking strain test of 103 tons per square inch: this test showing at the same time great resistance to dynamic and torsional tests. This is a combination of properties which has never been obtained before, and is the peculiar feature of the chrome-vanadium steels. The nickel-vanadium steels were of great strength, but showed much lower resistance to dynamic and torsional tests."

Steam Power from Waste Gases.

Consul J. I. Brittain, writing from Kehl, states that further successful experiments have been made in Germany by way of utilizing waste gases.

In a large cement works in south Germany twelve rotary kilns are used. The waste gases from these kilns have a temperature of about 1,000 degrees Fahrenheit, and further experiments have been made as to the possibility of using these gases instead of allowing them to go up the chimney. One great difficulty met with was the large amount of flue ash and fine raw materials which these kilns drive off and which threaten to clog any form of boiler. Special means were adopted for continually removing the flue ash. The plant now has eight of these boilers built behind rotaries, seven of which are in constant use. They produce steam at about 110 pounds pressure, entirely from the waste gases, and feed a 450-horsepower engine, which drives the whole rotary plant, as well as the coal-grinding plant. Whereas 450-horsepower formerly went up the chimney and an equal amount had to be produced elsewhere to drive the plant, this power is now entirely gained from the waste gases and will materially reduce the cost of fuel for manufacturing.

THE DESIGNER AND DRAFTSMAN.

The Art of Expression.

TO those who have had some experience in the metal arts, turn back in your mind a few years and see if you can not recall some experience that you have gone through, such as, say you were in the drafting room, pattern or machine shop, and there you recall the experience that you paid so dearly for, and as you go into details, and remember the job, that particular job that you received. It may have been a complicated one, and you had trouble understanding what was required, so calling your foreman or chief to you, you asked him to explain it so that you could go ahead.

Now, your chief was a first-class man, and and if he were doing the job himself he of course would have no trouble, but when it came to explaining it to someone else he, as a sailor would say, "struck a snag and grounded on the river of talk," or, to be more exact, his flow of language was limited; he could not put the problem before you so that you could understand some little detail that was of some importance toward a successful solution.

Now as you were at that time maybe a new man, and besides a young man, you naturally did not have that confidence that is born with experience, and not wishing to ask for more information, when especially he had shown by his manner that his way of explaining could not have been more concise, you stopped further consideration by letting him know that you understood him. Now you recall the mistake that you made and you also remember that his way of explaining was poor at the best, it being understood that in a way you were somewhat to blame, for if you had had some experience you could have seen beforehand what was required, but nevertheless the Art of Expression in that particular man was limited.

Now I have said a good deal about the other fellow; how about yourself? was it any better, your flow of language? I have had experience myself with other men, men who were "cracker-jacks" in their particular class of work, either in the drafting room or tool room; men who could take a job from the very foundation, you might say, and carry it safely through, i. e. make it mechanically perfect, or in the case of the tool-maker, who only receives the blue print, material and a few verbal instructions on a complicated jig, or fixture, who seems to grasp all the little details so necessary to make a successful mechanic. But when the superintendent or chief comes along and asks either one of them while they are working out their problems to explain the mode of procedure that they will adopt, say tomorrow, on some little kink on the job that all parties are interested in, and your chief in particular wishes to feel a little sure of, see if you can not recall an incident whereby these acts that I will relate suit you. Starting off at the very moment that you were asked, you got confused; tongue-tied besides, and taking the explanation by the tail (as it were) or, worse yet, you took it by the middle and began to explain it, and only after the super. drilling you for some time you got the subject in hand by the neck, and putting the explanation on its feet, you had it running smoothly on the right track.

Now to be, and what is of more importance at times, appear to be, well acquainted with what you are talking about (some may not agree with me here), it is not at all necessary to have a domineering way of talking, but a quiet, convincing and precise way of taking hold of it, just enough words to command respectful attention, for no one can help but to admire the man that has a fine flow of language. Such men are not to be met with in everyday walks of life, but do not necessarily imply that such men are a rarity, that they are the few who have received that gift, or, as they say, it was born in them especially. We have a tongue, too; give it some practice as they do, so that it will master a flow of language that anyone could be proud of. If you in your particular position at present have not the opportunity whereby you have a little talking to do, acquire it by talking to yourself; take it up in a systematic manner, take hold of some subject that you are interested in, and write a composition on it, and then study

your article and see if you can not take out or put in some words to give to it a better appearance, or, more precisely, a clearer meaning, and then repeat the article to yourself, and you will find that you have a flow of words that will be of some benefit to yourself and to others.

That is what I mean by the Art of Expression, that mastering of words that so few can control, and if you can master it you will find that it reacts in a substantial manner to yourself.

The Art of Expression in different literary subjects in the world of literature today has plenty of loop-holes for perfection, and maybe in the dim future we may all be able to dose some of them, but all we can do at present is to try to reach that goal that other men have set for us, and try to go beyond those points in the Art of Expression.

A. C. Jr.

Differential Gear in Chain Hoist.

THE following sketches show the application of an epicylic train of gearing to one of the many chain hoists on the market.

Fig. 1 shows the usual arrangement of gears in the standard block. In this train B is held stationary on the shaft. D is loose on the shaft, but fast to the load sprocket. C, C are idlers meshing with both B and D, and turning loose on their supporting pin. A is the sprocket over which the hand chain runs. B has one tooth more than D.

For example, say that D has 12 teeth and B 13 teeth. The number of teeth in C can be neglected as not effecting the speed. The result is that for every full turn of the load sprocket, sprocket A must make 12 revolutions. With 3 inches pitch diameter of the load sprocket, and 12 inches diameter of the sprocket A, then in order to raise a load up one foot 47 feet of hand chain will have to be hauled.

In connection with this chain block a little incident showing how essential is a knowledge of elementary mechanics in simple machine design will be noted. An old designer of various articles wished to make a high speed block from the one above described. The way he intended to get the high speed is shown in Fig. 2, and was by putting a pinion fast on the shaft with the hand chain sprocket, *a*, *which* meshes into a gear, *f*, loose on shaft. This gear was fast to a plate which held the idlers c, and c, and these were free to turn on their supporting pins.

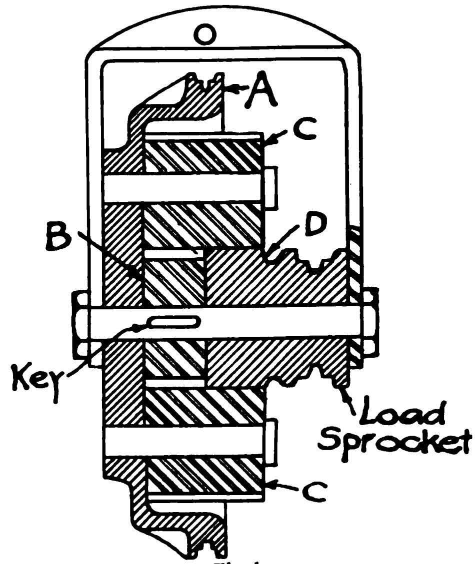


Fig. 1.

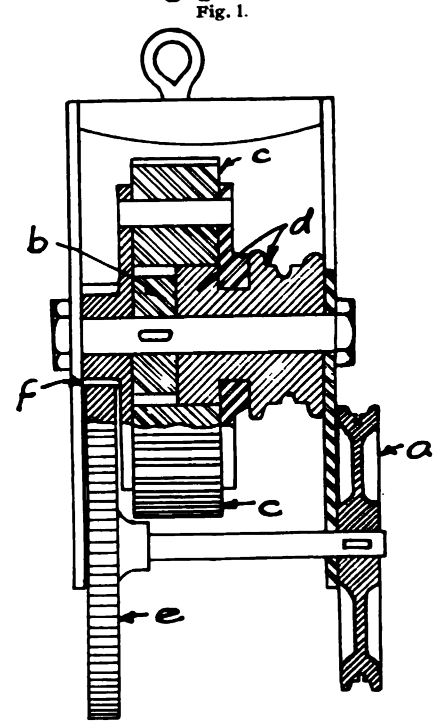


Fig. 2.

The speed was stepped up even higher thar I have indicated. I think it was to handk 500 pounds at about 200 feet per minute, a sort of dumbwaiter in disguise.

After a good deal of byplay, caused by a

mechanic pronouncing the design N. G., he finally, by giving a list of about 16 patents he had received on various things, got the general manager to have a high speed block of that design made up. The gears used were cut gears of steel, and the whole block was well built.

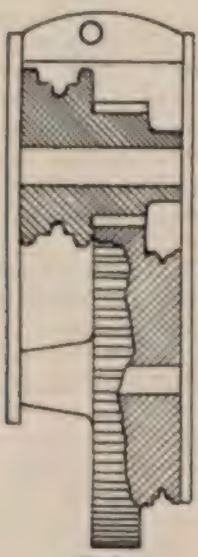


Fig. 3.

Upon the day of the trial 50 pounds was attached to the load hook. Then a man attempted to haul it up. It took 500 pounds to raise the 50 pounds, and even then it was not at 200 feet per minute.

When it was suggested that it would have been better to make it as in Fig. 3, as being less complicated, the designer took it as an insult.

L. E. Vator.

The most rapid railway construction ever recorded was that of the African line above Victoria Falls. Five and three-quarter miles of track were laid in twelve hours.

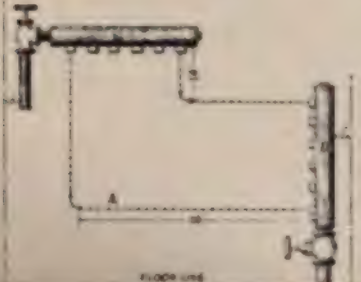


FIG. 1.

Pipe Coils for Heating.

BY J. B. MOONEY.

As a general thing, coils are made as long as the room or wall space where they are intended to be placed will allow them. The first thing to do is to find out what this length is and allow two or three inches of clearance on each end, as shown in Fig. 1, the dotted lines indicating the length of wall space where the coil is to be placed.

The complete manifold wall coil with upright expansion end is shown by Fig. 5. Where coils of this make are very long the expansion end would have to be higher, according to the length of the coil, to make a provision for the extra expansion, which might be considered to move about 1½ inches in 100 feet in

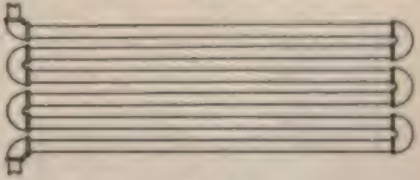


Fig. 2.

a change of temperature from 30 to 212 degrees, or about 1-900 of its length. This must be considered in the running of hot water or steam pipes of any kind. It is an easy matter where this style of coil is used to give it plenty of fall or pitch, as the flow of water or steam in it runs all in the same direction, that is, toward the outlet; and the more fall we give the coil, the better it will heat, or the more easy the circulation will be through it.

Another style of coil is that made by the use of return bends, as shown in Fig. 2. This style of coil will do for short lengths, but it is not a good heating coil for long lengths, and it is simply a continuation of a single pipe; and as it cannot have very much pitch or fall, it will not be very good for the ciculation of either water or steam through it.

Another form of coil where the return bend is used is shown in Fig. 3. This style of coil is known as a double return bend coil and is a great improvement over the coil illustrated by Fig. 2. As will be noticed, it is a continuation of two pipes instead of one. Two pipes are supplied by one connection in this case, where only one was supplied in the other, at the same time being the same distance apart, or, in other words, resting on the same size hook plates. The direction of circulation through this coil is shown by the direction of the arrows. This style of return bend coil is

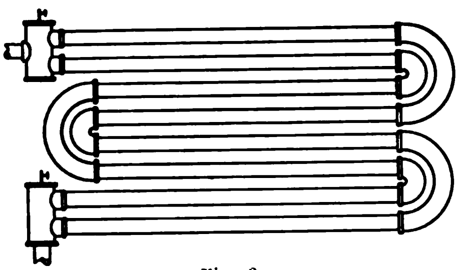
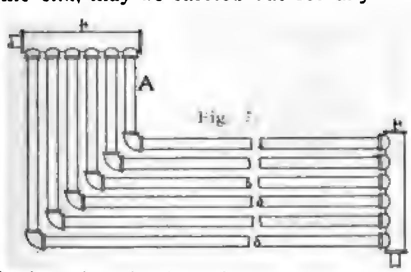


Fig. 3.

much better for hot water work than the single return bend or single connection, and is to be recommended for use in preference to the other for good results in heating.

This general principle of constructing wall coils, having the supply and return at the same end, may be carried out for any number



of pipes by simply using the regular manifolds on one end, and right and left elbows on the other end, as shown in Fig. 4. This arrangement of the pipes always provides for expansion, and is good for either steam or hot water heating.

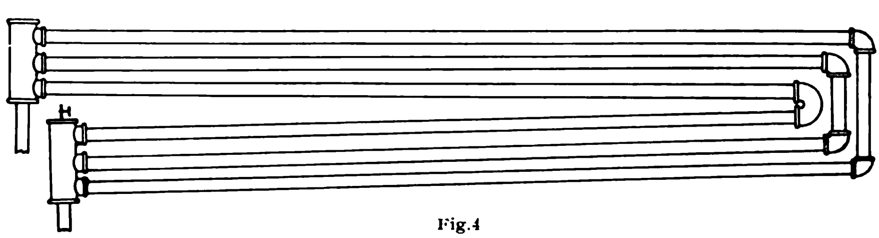


Fig. 4

Wherever possible long coils should be constructed so as to have the pipes divided into two parts, each with a manifold at the same end, one for the flow of hot water and the other to receive the return water, so that the temperature of water throughout the coil will be at a more average heat. The upper pipes will be warmest at the end nearest the flow manifold, but the return part of the coil directly under same will be the coldest, and therefore an equalization of the temperature in the coil is obtained at all points along the line. Where a long coil is used it is objectionable *to have* the supply end of the coil at one end of the room and the return end at the other end of the room, for this arrangement would give us two extremes of temperature at either end of the room.

The Force of Percussion in Hammers and Drills.

THE force of a blow from a hammer in the hand, of a drop press, a pile driver, a hammer, a rock drill, the falling of solid bodies, the water rain in pipes, and the power of projectiles, produce effects deductible from the general laws of dynamics applicable to such work.

The power of the hand hammer which has not as yet been classed among the "mechanical powers" without doubt deserves the place of honor as the most ancient and in many respects, the most wonderful mechanical power known. We daily see the results of its surpassing force, effected without the complication of levers, wheels or wedges; and apparently having some innate power superior to, and independent of the principles of mechanics as commonly studied.

In order to enable any one to make the complete computation of the velocity of a drop hammer in the drop press, a cushioned air hammer, or the monkey of a pile driver, when the velocity is due to gravity only, the power of impact at the moment of giving the blow may be ascertained from the known height at which the velocity of fall commences. The effect due to cushioning of air and spring hammers will be an acceleration of velocity due to the gross pressure at starting and will be described.

The square root of twice gravity ($\sqrt{64.33}$) multiplied by the sq. root of the height ($\sqrt{\text{height}}$) in feet; $\sqrt{2g \times h}$, or $8.02 \times \sqrt{h}$ = the velocity in feet per second at the instant of impact of a falling body.

Then one-half of the velocity $\times$ the

$\frac{\text{weight}}{\text{gravity}}$ $\frac{v^2}{2} \times \frac{w}{g}$, or, more simply, the height of the fall $\times$ by the weight, gives the number of foot pounds due to the fall, and the distance at which the force of the blow is arrested is the measure of the force of percussion of impact. It is as much more than the momentum in foot pounds as the distance of arrest bears to a foot.

Thus, if at half a foot the impact is twice the foot pounds, at 1 inch it is 12 times and so on through the fractions of an inch, at ¼ inch, it is 48 times and at 1-32 inch, it is 384 times. This latter arrest represents the impact of hardened surfaces where the elasticity of the metals largely represents the small movement, at impact, and of which the rebound of a hammer from the force of a hardened anvil represents the reactive effect of the foot pounds due to the momentum of the fall.

A small hammer swiftly wielded will accomplish that which would otherwise require a direct pressure of several tons. Seeking the cause of its mystic power, the principles of accumulated work or energy stored in weight and velocity will account for the varied effects we obtain.

In striking a blow with a hammer upon the head of a chisel, there are two forces brought into play, viz: The force of gravity and muscular force to increase the velocity, so that, at the instant of striking, the hammer may have a velocity of from 20 to 50 feet per second; the effect at this moment is the same as if the final velocity had existed throughout the whole of the stroke. Assuming 32 feet per second as the actual velocity at moment of impact, then the force will be the same as if the hammer had fallen from a height of the square of the velocity, divided by twice gravity $\left\{\frac{V^2}{2g}\right\}$, or $\frac{32^2}{64.33} = 16$ feet with a hammer weighing 2 pounds, then the accumulated work or energy will be $16 \times 2 = 32$ foot pounds.

Supposing that the face of the hammer moves one-eighth of an inch after touching the head of the chisel before the energy is all absorbed, then the result will be (approximately) the same as a direct pressure **or dead load of $32 \times \frac{12}{⅛} = 3{,}072$ lbs. or upward of 1½ net tons, but this is only partially true. The hammer may be self-adjusting mechanical power, for if the material be harder so as to give more resistance to the chisel, the cut will not be so great and therefore the force of percussion will be greater. For instance, if the movement of the chisel, as above stated, had been only one-sixteenth of an inch, the force would have been doubled, or equal to a pressure of 3 tons instead of 1½ tons. But there is a limit to the effect; otherwise the blow would be measured by thousands of tons. until the rigidity of the mass receiving the blow was balanced by the elasticity of the material giving or receiving the blow. This is beautifully illustrated when striking the hardened face of an anvil with a hammer, where nearly the whole force of the blow is returned in the rebound of the hammer.**

Notes on the Use and Power of Paper Frictions.

WITH the rapidly increasing use of paper friction wheels in the transmission of power, for both light and moderately heavy service, comes the need of more general information than now exists among designers and power users relative to this type of gearing. An enumeration of the various applications of paper frictions which are matters of regular engineering practice cannot be attempted here, but would include hoisting machinery, reverse-motion driving, "sensitive" movements, variable-speed devices, intermittent motions, etc. There are a number of cases in special machine construction where the paper friction has proven to be the only practicable solution of the peculiar problems therein presented. This type of gearing, therefore, occupies a position of recognized importance in the mechanical field, and bids fair to grow into further and greater usefulness.

Spurs, mitres and bevels, as with toothed gearing, are commonly employed, and the analogy between the two types in these three forms is, in most respects, quite general. It is a familiar fact that, in learning the theory of toothed gearing, the mind is called upon to consider two cylindrical or conical surfaces rolling in contact, these being defined as the pitch surfaces of the gears, the teeth serving simply to insure positive relative motion. Emphasis is laid upon the necessity for maintaining the theoretical integrity of rolling contact between the pitch surfaces, in order to ren-

der the gears most nearly correct in their action. In the case of frictions, the untoothed pitch surfaces of the mating wheels are employed, the positiveness of relative motion being either undesirable or not essntial. The wheels depend for their driving value upon the coefficient of friction of the paper wheel against its iron mate, and their actual driving capacity becomes a function of the pressure with which they are held in contact.

This pressure must be limited by the ability of the paper surface to endure it without injury; and herein lies one of the important features of the design and construction of paper friction wheels. The friction material must be of the firmest possible texture to enable it to endure the high pressures desirable, yet without reduction of its coefficient of friction in use against the iron of a mating wheel. A small loss in this respect would destroy the effects of a large gain in pressure-enduring qualities. Friction materials are now available for this work, combining the essential qualities of durability and driving power to a very satisfactory degree.

The designer and maker having done their part, the purchaser and user must exercise proper judgment and care in the adaptation of the wheels to their service conditions. The paper wheel should never be used as the driven member of a pair of wheels, since, being of the softer material, its surface would be injured and eventually ruined by the even occasional and momentary rotation of the iron wheel against it under pressure before starting it from rest or after an excessive load has brought it to a standstill.

Friction being essential to the usefulness of this type of gearing, care should be taken to prevent any considerable reduction of the driving power by the access of grease or other foreign matter to the surfaces. The wheels should be kept clean and protected, in the few cases where it may be necessary, by guards or other means which will exclude undesirable substances.

Rigid support for the shafts should be provided, preferably adjacent to the wheels themselves, on one or both sides. This is especially true of mitres and bevels, although by no means of small importance in all cases, to afford proper assurance of maintaining good driving contact across the faces. The wider the faces, the more vital is this point, and the more difficult it is to accomplish. This being the case, faces should be kept as narrow as is consistent with other conditions, remembering that, for a given power and rotative speed, the diameter must increase as the face decreases.

Contact pressure should be applied in the manner best adapted to conditions. In general, the lever-operated eccentric box or thrust box is commonly used as a simple method of giving easy hand or power control to the manipulation of the mechanism. In special cases more elaborate devices are used, being often incorporated in the general design of machines of which the frictions form component parts. The pressure may thus be positively applied, and may be made to vary with the load to be driven, increasing and decreasing as the work requires, and being always just great enough to drive the load. Such automatic devices save losses from unnecessary bearing friction, etc., and add to the life of the paper wheel.

In selecting a set of wheels for a given service, generous estimates of power requirements should be made, including allowances for possible future increases of load, failure to maintain good conditions in the respects already mentioned, and also the necessity, where it exists, for starting from rest under full load. In the last case, of course, momentarily excessive contact pressure may be effective, but should not be so great as to cause injury.

For the purpose of determining the power-transmitting capacity, or horse-power rating, of paper frictions, as well as such other characteristics as might present themselves, an extended series of tests were made some time since at the laboratories of Purdue University, La Fayette, Indiana, under the directions of Prof. Goss, by whom the results were reported in a paper read before the American Society of Mechanical Engineers and recorded in Vol. XVIII of the Transactions of that society. A number of wheels of various sizes, made by the Rockwood Manufacturing Company, were tested in a machine especially designed and constructed for the purpose. These tests show, among other things, that the most efficient working pressure is 150 pounds per inch of face, and that at that pressure a slippage of about 2 per cent. will result while driving loads corresponding to a coefficient of friction of 0.2. The horse-power formula derived from these tests may be written as

$H = .0000061\ P\ W\ S$; or, $H = .0000016\ P\ W\ D\ N$, in which

H=Horse power.

P=Pressure between the wheels in pounds per inch of face.

W=Width of face in inches.

S=Surface speed in feet per minute.

D=Diameter in inches. (For mitres and bevels, use mean or average diameter.)

N=Number of rotations per minute.

This formula involves the coefficient of friction, 0.2, but leaves the matter of pressure, P, to individual choice. One hundred and fifty is a safe and conservative value for P, and may be used in the absence of preferences or experience otherwise, with confidence that, in general, it will make proper allowance for the varying and possibly indeterminate features to which attention has been called. Higher pressures may be used where all conditions are definitely known, or where experience has proven their use permissible. Higher pressures enable the transmission of greater power with a given wheel, and at the present time wheels are being made which will readily allow the use of working pressures of 250 pounds and more. With a coefficient of friction of 0.2, the tangential driving force, T, at the line of contact between two wheels is, of course, one-fifth of the pressure, P. This driving force, therefore, may be used as the basis of power calculations, in which case the foregoing formula would take the form

$H = .0000305\ T\ W\ S$; or, $H = .000008\ T\ W\ D\ N$.

The data here given was furnished by the Rockwood Mfg Co., Indianapolis, Ind

The Size of Fir Joists.

The common rule is half span in feet plus two equals depth in inches and one-third of the depth equals the thickness.

Thus a 14 foot span is $14 \div 2 + 2 = 9$ inches deep and $9 \div 3 = 3$ inches thick.

A simple formula for the strength of a fir beam, allowing a factor of safety of 7 is $W = bd^2 + L$, where W = safe load cwts. distributed b = breadth in inches, d = depth in inches, L = span in feet.

Then a 9x3 inch joist over 14 feet span equal $bd^2 \div L = 3 \times 9^2 \div 14 = 17.3$ cwts. distributed.

Assuming the joist to be 12 inches apart or 15 inches center to center, this will give a safe load of $14 \times 15\text{-}32 \div 17.3$ = say 1 cwt. per superficial foot.—Architects' Magazine.

Forced Contrasts.

BY G. H. LOCKWOOD,

Chief Art Instructor in the Acme School of Drawing, Kalamazoo, Mich.

IN making pen and ink drawings, especially for newspaper reproductions and coarse printing, it is necessary to "force" your contrasts, that is, make your shadows darker and your highlights lighter than they appear in Nature. For instance, take a picture with a camera and then let a newspaper artist sketch the same study. The camera takes everything not in too rapid motion, and even then it makes the attempt, resulting in a "blur" on the print; all minute variations of color tones, as well as all detail are shown in their natural relation to each other, the result is a more or less uniform gray tone. How different the artist's sketch, which stands out clear and sharp; all unimportant detail is entirely missing, or barely suggested by a few light lines; light tones are left white and dark tones are made black. The many shadings of gray, varying all the way from white to black, are simplified into one or two uniform tints and the values are rearranged so that the principle object, the idea, stands out clearly while everything else is subordinated.

An attempt to copy Nature accurately and minutely would certainly result in failure. But this is not art, the true artist does not try o represent, but to "suggest" Nature in his work; the mind of the observer must do much to complete the picture, as it always does, usually unconsciously. The artist then must deal with thoughts, ideas, even more than with lines. He must be able to use lines, color tones, briefly, technique to convey thoughts from his own mind, first to paper and then to the mind of the observer. To make this clear: no artist ever drew a tree with its corrugated trunk, myriads of twigs and stems and variagated foliage; to accurately draw one leaf, in all its minute detail, would be a very difficult, if not impossible, task—what the artist does is to make a few marks that "suggest" to the observer the form of a tree, in fact, the more that is left for the observer's mind to fill in the better, provided the "suggestion" is strong enough to make this possible.

The best drawing of a tree is not the one

with the most detail in it, but the one with the strongest "suggestion" in it. The amateur will make a tree, using a great many lines and trying to draw limbs, stems and leaves; the result is a botch and the mind of the observer is at once attracted to the technique in the drawing; it does not see a tree but a lot of lines and scratches. The adept will make a few dashy strokes, leave a few white places, put in a few heavy blacks and lo—the mind sees a tree—the technique, the lines and white places and black places, is not noticed—the idea is grasped and what the artist could not draw he has suggested, the observer sees it, and in his mind is good.

To make these suggestions strong this is the main point, and to do this it is necessary to subordinate detail to idea, simplify and cut out; force the values and, in a general way, to strengthen the main features and weaken or eliminate everything else. And above all, avoid a uniform gray effect in the general appearance of your drawing. Keep close to the three-tone contrast arrangement of values until you have thoroughly mastered the essential principles of outline and light and shade.

Costliness of India Ink.

"This india ink," said the clever Chinese art student, "has no more right to be called Indian than your American redskins have to that name. For india ink comes from China and India never produces a drop of it.

"Anhui, my own province, is the one where india ink is made. The best of the ink is kept at home, for the use of the royal scribes and the official literati. It is only the lower grade that is exported. This lower grade sells at wholesale in Anhui for $1,500 a ton.

"The very best grade india ink, the kind rich with gold, is worth $75,000 a ton.

"The constituents of india ink are colza oil, pork fat, lampblack, glue, musk, gold leaf, and the oil of a poisonous tree, the heng, which grows only in the Yangste valley.

"After the admixture of the oils, the lampblack, the fat and the glue, the resultant paste is beaten for many hours with steel hammers upon wooden anvils, and during that long beating certain quantities of musk and gold leaf are added, the musk to give the ink a perfume, the gold to give it luster.

"Afterward the ink is dried for three weeks in molds. The stocks are then decorated, the most artistic scribes gilding them with very beautiful Chinese characters.

"There is no ink worthy to be mentioned in the same breath with ours, an ink redolent of musk and bright with gold."

Strength of Steel Necessary in Reinforced Concrete.

AUTHORITIES disagree utterly as to the matter of the strength of steel necessary in reinforced work. Writing to the *Engineering News*, Mr. Michael Morssen, of New York, takes exception to the formula suggested by Mr. Edward Godfrey in the *News*, and bases his objection on the findings and practices of other authorities. According to tests made, adhesion between steel and concrete decreases with the diameter of the embedded rods. Mr. Godfrey lays down the rule that a rod of no more than 1/200 of the span of the beam should be used. Mr. Morssen points out that in a beam with a span of 6 feet, this rule would result in the use of a 3/8-inch rod, from the following equation:

$$\frac{6 \times 12}{200} = 0.36 \text{ inch, or about } 3/8 \text{ inch.}$$

"A good designer," says Mr. Morssen, "will never use 3/8-inch rods in a beam. Rods for beams especially should have sufficient stiffness not to bend at many points under the load of concrete. If too small rods are used, it will be very difficult to assure their distance from the bottom. To choose the proper diameter of the rods in each case, the designer should have had practical experience; otherwise he may sometimes choose rods not easy to handle and which will not always allow him to get into the work the reinforcement made with a pencil on drawing paper in the office."—*Concrete*.

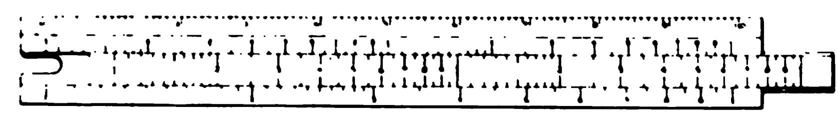
The A. L. A. M. Standard Screw.

THE A. L. A. M. standard screw is a new standard evolved from the old U. S. standard, using the latter as a basis. There is nothing revolutionary in its adoption, as it merely conforms to the general practice of many machine tool and automobile builders in establishing a standard in constructive material. A finer thread than that used in the U. S. standard has been found neessary, but, like any new standard, it cannot be expected that it will be immediately or universally adopted, but it is believed that it will gradually come into use.

Considerable study was put on the dimensions of the nuts and heads, and careful destructive tests were made before the standard was adopted, so as to prove to a certainty that the nuts and heads were large enough and that the threads would not strip. These tests were made with ordinary material and with the material it is proposed to use for automobile work, and the results were the same in both cases—the screw broke at the base of the thread inside the nut. The material to be used in A. L. A. M. plants in automatic work (and which can be easily worked in automatic screw machines) is said to be about twice as strong as ordinary screw stock, and very much tougher, being lower in the impurities and showing a very fine fracture, a characteristic of tough steel.

THE RUNNERLESS SLIDE RULE is the title of a little booklet of about 40 pages by F. F. Nickel, 27 Winans St., East Orange, N. J., devoted to explaining the advantages of the instrument which the title aptly describes.

The common form of slide rule now in use is the one embodying the arrangement of scales introduced by Lieut. Mannheim, who changed the division of the lower scale of the slide and therefore had to add the glass runner in order to be able to transfer the lines from the lower scale of the rule to the upper



scale of the slide. To solve a comparatively simple problem, it was therefore necessary to set the slide and set the runner, requiring two settings, and oftentimes three, against one setting on the runnerless rule.

The instrument whch is intended to be sold with this treatise was manufactured in accordance with the author's specifications, whose foremost aim was simplicity.

The arrangement of the scales in this instrument is as follows:

1 -Upper scale of RULE.
2- -Upper scale of SLIDE.
4—Lower scale of SLIDE.
3--Lower scale of RULE.

The divisions of scale No. 1 and 2 are precisely the same as in the common or Mannheim form, as is also No. 3. In scale No. 4 of this rule the division is the same as scale No. 2, and it is on account of this arrangement that it is possible to do away with the glass runner and save making the extra setting which the use of the runner involves.

The treatise gives many examples showing the time saving value of this feature and also an original and highly interesting method of finding the decimal point, that "bugbear" to every beginner of the use of the slide rule.

All marks (for *pi* and other constants) and all unnecessary lines are omitted, and only those figures are given which are indispensable for quickly arriving at the value of each individual line.

The centre space of the rule, or the groove, is left entirely blank, so as to provide a convenient place for notes and marks without the necessity of defacing the scales.

The bevel edge is divided into inches and tenths of inches, consistent with the decimal division of the scales. This will be found convenient to measure and compute distances on charts, diagrams, maps, etc., which are drawn to a decimal scale.

All scales are celluloid covered and have lines black and white.

The price of the booklet sold separately is 50c and we believe every user of the slide rule would profit by the suggestions it contains even in the use of an old form of instrument.

The price of the runneress slide rule with the booklet is $3.00 each, sent post paid to any part of the U. S. upon receipt of price.

College Notes.

The dedicatory exercises of the Engineering Building of the University of Pennsylvania, West Philadelphia, were held October 20, 1906. This building will be used for the engineering department of the University.

The Winona Technical Institute is a group of trade schools containing the following departments: Electrical, Printing, Lithography, Foundry, Tile and Mantel Setting, Carpentry and Library. Five of these departments are

operated by national organizations, namely the National Founders' Association, The National Electric Contractors Association, the National Association of Employing Lithographers, the Tile Manufacturers' Credit Association and the United Typothetae of American. There is at present upward of 200 students who are doing unique work in trade preparation. The institute has been in process of organization and development some two years now and the trustees think they are making a valuable contribution to the problem of industrial education.

The Institute is situated at Indianapolis, Ind., with commodious grounds dotted with substantial buidings.

Purdue University, La Fayette, Ind., on September 12th, entered upon its thirty-third year. At the end of the second week, 1,588 students had been enrolled. Out of this number, 1,379, or 86 per cent were registered in the schools of engineering.

New appointments to the instructional staff of the engineering departments for the present year have been announced as follows: W. K. Hatt, Ph. D., formerly Professor of Applied Mechanics, to be Professor of Civil Engineering in charge of the department; Mr. Paul B. Brenneman, B. S. 1894, C. E. 1897, State College of Pennsylvania, formerly engineer and superintendent mining construction and operation, to be instructor in Civil Engineering; Mr. Arthur W. Cole, B. S. Worcester Polytechnic Institute, 1902, formerly of the University of Maine, to be instructor in Thermodynamics; Mr. L. W. Wallace, B. S. Texas A. & M. College, 1903, late with the motive power department of the Sante Fe Railroad, to be instructor in Car and Locomotive Design; Mr. W. T. Small, B. S. Purdue 1903, formerly with the Cooper-Hewitt Electric Company, to be instrutor in the electrical laboratory; Mr. C. E. Schutt, B. S. Purdue 1905, formerly with the New York Telephone Company, Mr. George Lamke, B. S. University of Michigan 1906, and Mr. W. A. Rush, B. S. Purdue 1906, to be assistants in the electrical laboratory; Mr. R. D. Kneale, B. S. Purdue 1906 and Mr. M. L. Allen, B. S. University of Wisconsin, 1906, to be assistants in the civil engineering department.

The facilities of the engineering department have been increased by the completion of a building containing three floors, each *75 x 130* feet for the Department of Civil Engineering, and by an addition to the Electrical Laboratory 68 x 90 feet to give room for additional equipment. This room is to be served by a traveling crane which may be utilized in transferring heavy equipment from the laboratory to a new lecture room which adjoins. There have been added to the Materials Testing Laboratory and to the Steam Engine Laboratory a number of important machines including a 100,000 pound Olsen testing machine, a Fairbanks-Morse 50 horsepower gas producer and gas engine, a 20 horsepower DeLava 1 steam turbine with direct-connected centrifugal pump, a 16 and 10 x 14 air and 11 and 18 x 14 steam Ingersoll-Rand air compressor, a Foster superheater of the type supplied by the Power Specialty Company, a Gerry-Emmons gasoline engine, an Abner Doble water motor, and an Allis-Chalmers 8 x 24 Corliss engine direct-connected with a centrifugal pump of 4,000 gallons capacity.

With a larger instructional staff, and with a considerable amount of new equipment, it is expected that the larger classes of the present year will be handled as efficiently as have been the smaller classes of previous years.

Question Box.

9. Please give me formulae for obtaining the dihedral angles formed by the sides of a hopper; one that will apply to symmetrical as well as unsymmetrical ones, having given the dimensions found on the enclosed sketches.

In Fig. 1 are shown two views of a symmetrical hopper in which the dimensions c and d are given. The problem is to find the dihedral angle formed by the faces S and T, having given the dimensions c and d. Draw the line w m through the two projections of the point o. Through m draw the line m n perpendicular to o p. This line will be the view of a plane perpendicular to the line o p. In Fig. 2 is shown the true shape of the surface made by this plane, giving the magnitude of the required angle z.

To find this angle, proceed as follows:

$$g = \sqrt{2d^2}$$

$$e = \sqrt{g^2+c^2} = \sqrt{c^2+2d^2}$$

Triangle o p m and o m n are similar triangles. Therefore $g:h = e:c$, or $g\,c = h\,e$, or

$$h = \frac{gc}{e} = \frac{c\sqrt{2d^2}}{\sqrt{c^2+2d^2}}$$

$k = 2g = c\sqrt{2d^2}$

Angle X = Angle Y = ½ Angle Z.

$$\text{Tan } \tfrac{1}{2} Z = \frac{\frac{k}{2}}{h} = \frac{g}{h} = \frac{\sqrt{2d^2}}{\frac{c\sqrt{2d^2}}{\sqrt{c^2+2d^2}}} = \frac{\sqrt{c^2+2d^2}}{c}$$

One corner of the unsymmetrical hopper will be sufficient for illustration. Fig. 3 gives two views in which the dimensions a, b and c are known. Fig. 4 shows an oblique projection in which the line of intersection between S and T is shown in its true length and Fig. 5 gives the true shape, showing the true magnitude of the angle Z. To find the angle Z, proceed as follows:

Angle X + Angle Y = Angle Z.

$f = \sqrt{d^2 + b^2}$

$g = \sqrt{c^2 + b^2}$

$b : d = f : h$

or $df = bh$

$$h = \frac{d\sqrt{d^2 + b^2}}{b}$$

$k : b = f : d$

or $k d = b f$

$$k = \frac{b\sqrt{d^2 + b^2}}{d}$$

$m = \sqrt{g^2 + d^2}$

$c : n = f : m$

or $c m = f n$

$$n = \frac{c m}{f}$$

Substituting values of m and f we have

$$n = \frac{c\sqrt{g^2 + d^2}}{\sqrt{d^2 + b^2}} = \frac{c\sqrt{c^2+b^2+d^2}}{\sqrt{d^2 + b^2}}$$

$$\text{Tan } X = \frac{k}{n}$$

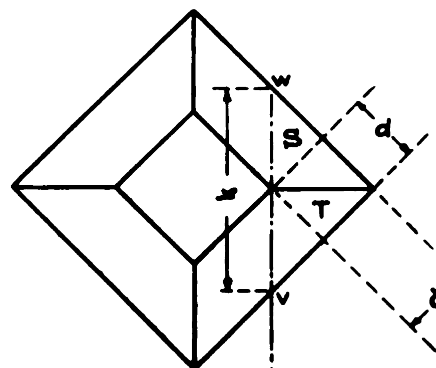


Fig 1.

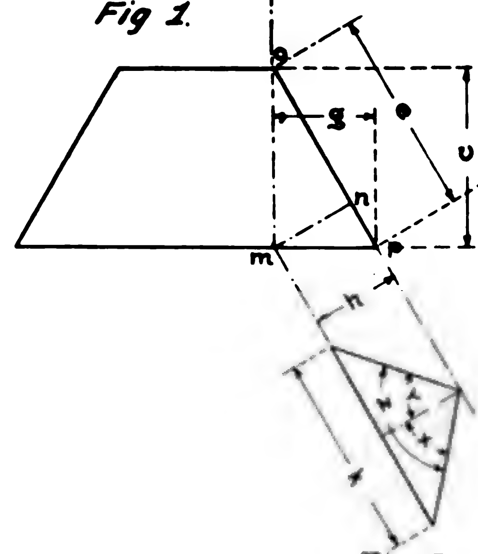


Fig. 2.

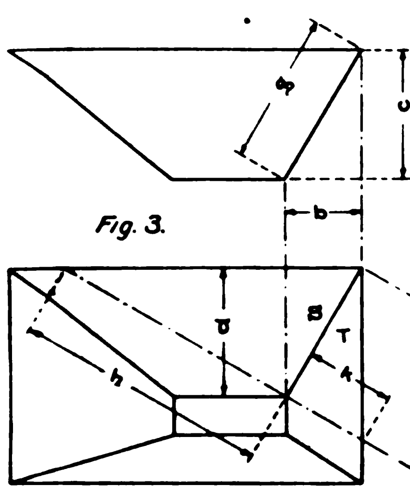
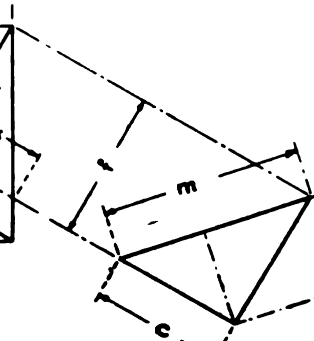


Fig. 3.



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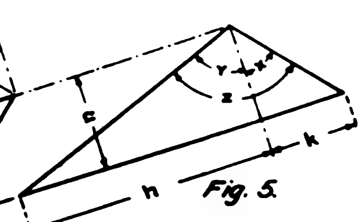


Fig. 5.

Substituting we have

$$\text{Tan X} = \frac{\dfrac{b\sqrt{d^2 + b^2}}{d}}{\dfrac{c\sqrt{c^2+b^2+d^2}}{\sqrt{d^2 + b^2}}} = \frac{b\,d^2 + b^3}{dc\sqrt{c^2+b^2+d^2}}$$

$$\text{Tan Y} = \frac{h}{n}$$

Substituting values of h and n, we have

$$\text{TanY} = \frac{\dfrac{d\sqrt{d^2 + b^2}}{b}}{\dfrac{c\sqrt{c^2+b^2+d^2}}{\sqrt{d^2 + b^2}}} = \frac{d\,b^2 + d^3}{bc\sqrt{c^2+b^2+d^2}}$$

EDITORIAL COMMENT.

IN his New York speech Mr. William Jennings Bryan proposed that the trusts be curbed "by refusing a license to any corporation which controls more than a certain portion of the total product—this proportion to be arbitrarily fixed at a point which will give free operation to competition." Mr. Geo. Smart, editor of the *Iron Trade Review*, wrote Mr. Bryan for the proportion he would fix. Mr. Bryan replied: "I am not prepared to state just how much a proportion a corporation can control without becoming a trust, in the sense that it limits competition and competition controls the the price and terms of sales. For the conduct of. my own paper I draw the line at 50 per cent and do not accept an advertisement of a corporation controlling more than 50 per cent of the product in which it deals."

The *Iron Trade Review* states editorially: "To subject the great industries of the country to any such control as he advocates would be to place them in the hands of government officials, who would probably have no exact knowledge in regard to the different industries, thereby establishing autocratic power, which would not be tolerated in any democratic country." Of course not, but if no one else wanted to make the commodity then the corporation producing the article could not be called a "trust" for by definition a trust is a combination or union of corporations or concerns. A single corporation is not a trust until it becomes the controlling element of other concerns that are subject to the dictates of the first one in question. No man is a trust if he is accused of controlling more than 50 per cent of the output of the party ideas.

Mr. Bryan has been ridiculed considerably, but not rightly, for he does not mean to cut off the output of a concern who are doing a legitimate business even if they do build over 50 per cent of all the machines sold of that particular class. When two or more concerns get together to control the output then Mr. Bryan's proposition should decide whether they are a trust, and whether they need regulating by the government.

Browning's Industrial Magazine (formerly The Draftsman) contains notices such as the folowing which may be of interest to you:

The U. S. Civil Service Commission announces examinations on Nov. 20-21-22, 1906, to secure eligibles from which to make certification to fill vacancies in Supervising Architect's Office, 20 Architectural Draftsmen at $1,400 to $1,800 per annum, 38 junior Draftsmen at $840 to $1,200 per annum, 2 engineer Draftsman (Structural) at $1,600 to $1,800, 5 Electrical Engineers and Draftsman at $1,200 to $1,800 per annum, 5 Heating and Ventilating Draftsmen at $1,200 to $1,600 per annum and in the Bureau of Animal Industry, 1 Junior Architectural Draftsman at $900.00 per annum. Ask for forms 1312 and 1943. On Nov. 30 and Dec. 1 an examination for assistants in Philippine School Service at an average entrance salary of $1,200.00. Ask for form No. 1967 and application form No. 2 and No. 375. On Nov. 21, 1906, an examination for Expert Lock Fitter at P. O. Dept., Washington, at $3.25 per day. Ask for form No. 1093. On Nov. 14, 1906, an examination for Electrician in Quartermaster's Department at Large, Fort D. A. Russel, Wyo., at a salary of $1,000 per year. Ask for form No. 1052. Address Civil Service Commission, Washington, D. C.

BOOKS AND CATALOGS.

Book Reviews.

ELEMENTARY Mechanics, by George A. Merrill, principal of the Cal. School of Mechanical Arts and director of Wilmerding School of Industrial Arts, San Francisco.

This book is intended for upper classes in secondary schools and for the two lower classes in college. It is almost alone in its field since so much of this kind of matter is only found in a rather condensed form in the text books of Physics.

The subdivisions of the book are, Kinematics, Statics, Kinetics, Dynamics, Basis of Mechanics, some of its Fundamental Conceptions, Greek Alphabet and some English and Metric Equivalents.

There are 168 illustrations and 262 pages including tables of trigonometric functions.

A great amount of practical matter is contained between the covers. The book is well bound and printed and published by the American Book Co., Cincinnati, Ohio.

The Essential Data of Bevel Gearing, a reference book for shop and drafting room.

This is a compilation of upwards of 70,000 computed items together with numerous drawings, tables and explanatory matter calculated to eliminate much of the mathematical drudgery in gear design. The range of combinations will be found to cover nearly every need of ordinary practice. The book begins with the relative size of tooth at large and small ends and this is illustrated.

Eighteen pages containing descriptive matter with conversion tables, proportions of tooth parts, etc., are followed by nearly 250 more of computed tables.

All angles read to the nearest tenth of a degree and dimensions to the nearest hundredth of an inch for one-pitch tooth.

Mr Edward J. Frost, 301 1st St., Jackson, Mich., is the author and publisher, who will send circular matter.

Lettering, Topographical and Conventional Signs, etc., for Engineers and Draftsmen is the title of a collection of sixteen blue prints 8½ " x 14" made by Mr. J. C. Corleissen.

The prints are loose and are placed in a neat black cloth case for protection.

The topographical signs are practically standards adopted by railway and surveyor offices and are beautifully executed. Every office and school should have a set as the print can be placed under a tracing and copied. A plate of borders accompany the set. Price $2.00. Address Browning's Industrial Magazine, Collinwood, O.

Catalogs.

The Dayton Electrical Mfg. Co. Dayton, O., have issued a four page bulletin in which they describe the Apple ignition system for 1906.

Throttling and Automatic Single Valve Engines are described in Bulletin No. 131, issued by the Atlas Engine Works, Indianapolis, Ind.

Wm. Sellers & Co., Philadelphia, Pa., have issued a catalog on cranes, including electric traveling wall jib, overhead and locomotive ranes.

The Quincy-Manchester, Sargeant Co., of Chicago, Ill., and New York issued a bulletin on "Riveters" in many styles for a great variety of work.

The Roberts & Abbott Co., Engineers, Schofield Bldg., Cleveland, O., have issued a circular on the subject of Industrial and Architectural Engineering.

The Association of Licensed Automobile Manufacturers, 7 East Forty-second St., New York, have issued their bulletin No. 18, in which they advertise Hexagon Head Screws, Castle and Plain Nuts, etc. There are six sheets shown on which several views of the screws and nuts are given.

The Municipal Engineering & Contracting Co., Chicago, Ill., describe their concrete mixers in a little booklet, which contains many testimonials from firms using their mixers.

The McGraw Publishing Co. have reprinted from the *Engineering Record* an article on the United States eight hour law. It is edited by Wm. B. King, 1028 17th St., Washington, D. C.

The C. W. Hunt Co., West New Brighton, N. Y., have issued a catalogue No. 053 on the Hunt Noiseless Conveyor and other machinery for handling coal and ashes in Power Stations.

The American Wood Working Machinery Co., of Chicago, New Orleans, Cleveland and New York have issued a bulletin in which they advertise their Patent Universal Saw Benches.

Lidgerwood Engines for use with Hayward Buckets are illustrated and described in a neat little catalog issued by the Lidgerwood Manufacturing Co., 96 Liberty St., New York, N. Y.

The General Electric Co., Schenectady, N. Y., have issued a bulletin describing Low Voltage Three-phase Generator and Feeder Panels. They also describe Equipment of Panels, Instruments, Air Brake Switches, Oil Switches, etc.

The Thew Automatic Shovel Co., Lorain, O., have issued a catalog No. 4 in which they describe Steam Shovels, Excavators and Dredges for mines, smelters, blast furnaces, ore docks, brickyards, and cement works, railroads and contractors.

The Bates-Corliss Engine, Cookson Improved Feed Water Heaters, Cookson Improved Heaters and Receivers, complete power plants, power-transmitting machinery, Heavy Band Fly Wheels are fully described in a two part catalog issued by The Bates Machine Co., Joilet, Ill. There are many testimonials in the rear part of the book.

The Mongahela Manufacturing Co., Mongahela, Ala., sent a large catalog of Industrial Railways and Appliances, such as cars, *switches*, locomotives, track, etc., that have been built by the Hoshor Platt Co. The catalog also contains coal and ash handling machinery of a large variety.

The Richardson Scale Co., Park Row Bldg., New York, have sent in two photographs one showing plant designed and erected for the Brooklyn Railroad Co., Brooklyn, N. Y., by the Robins Conveying Belt Co., The Link Belt Machinery Co. and the Richardson Scale Co. The other shows part of an installation of 9 "Richardson" Automatic Coal Scales.

The results of tests made in the Collective Portland Cement Exhibit and Model Testing Laboratory of the Association of American Portland Cement Manufacturers in the Louisiana Purchase Exposition has been put into booklet form, occupying 36 pages, was issued by the Association of American Portland Cement Manufacturers and the Society for Testing Materials.

The Ernst Wiener Co., New York City, have issued their catalog No. 50 in which they describe Railway Materials for all Industries, such as Portable, Industrial and Permanent Tracks, Industrial Track Layouts, etc., Switches, Frogs and Crossings, Turntables and Transfer Cars, and Steel and Wooden Cars of every description for all industrial purposes, Cableways for Quarries, Brickyards, and similar purposes.

THE LIGHTING OF PUBLIC BUILDINGS is ably discussed in a booklet under that title, published by the Nernst Lamp Co., Pittsburg, Pa.

THE SOLOMONSON OPTICAL CO., of Cleveland, O., have issued a 7 x 11 catalog of 222 pages in which they advertise drawing materials and mathematical instruments.

NEWHALL CHAIN FORGE AND IRON CO., New York, have issued their catalog No. 101, which is descriptive of hand forged crane, block and hoisting chain, and method of manufacture.

JAMES L. ROBERTSON & SONS, 204 Fulton St., New York, describe **Eureka** packing in a small booklet about the size of a large envelope.

MR. G. H. HULETT.

There is presented above the photogravure of MR. G. H. HULETT, well known in engineering circles as an inventor and designer of material-handling and labor-saving machinery. Born in Conneaut, Ohio, in 1846, Mr. Hulett after a common school education and two years in a seminary engaged in mercantile business. Then in manufacturing, taking up the study of engineering at the same time, and was first engaged in building coal and ore-handling machinery in Cleveland in 1885. Later he was associated with the McMyler Manufacturing Co. for five years, during which time he designed and patented end and side dump car unloaders, and numerous other labor-saving machines. For the next five years he was jointly interested with the Webster, Camp & Lane Co., of Akron, O., in building ore and coal machinery, including the Hulett Automatic Movable Car Dumpers for ore yards. When the Akron company was consolidated with the Wellman-Seaver-Morgan Co., he became a vice-president of this engineering concern, in charge of the ore and coal handling machinery department.

Browning's

Industrial Magazine

VOL. 5 DECEMBER, 1906 NO. 12

The Wrecking Crane and Its Crew.

ON Sunday afternoon, Oct. 28, a train of three electric cars on the West Jersey & Seashore R. R., a branch line of the Pennsylvania R. R., recently equipped for electrical operation, was derailed at the Thoroughfare drawbridge on the outskirts of Atlantic City, N. J., and all of the cars fell into the water. The first two cars were entirely submerged and the third took an inclined position with the forward end under water and the rear resting upon the pile pier at the end of the draw span. At least 56 persons were drowned. The motorman went down with his car and was drowned, but the conductor and rear brakeman escaped. They state that the train was carrying about 100 passengers. As near as can be ascertained all of the passengers in the first two cars were killed, but all or nearly all of those in the rear car were saved by crawling from the rear door. In the absence of the coroner's report and of any official report from the railroad company, a satisfactory explanation of the cause of the wreck cannot be learned. It is said that the bridge had been swung to permit a boat to pass about half an hour before the arrival of the train, but that the span had been closed and the rails properly set. The press accounts are conflicting on the point as to whether or not the bridge was protected with interlocking signals."

Such notices are of daily appearance and call for no comment unless a large number of persons are killed or the wreck was caused by something unusual, so common are their occurrence.

The picture on the cover of this issue was taken at the scene of this wreck, and illustrates the use of a wrecking crane.

The cause of the wreck noticed above is in doubt, many of the disasters are from unknown causes and the broken truck or sprung rail may be the result rather than the cause of many wrecks.

Perhaps wrecks were more numerous years ago, before the adoption of so many safety appliances that are now in use, but the growing impatience of the present generation is cause for comment in connection with the wreck problem.

The demand for longer distance covered in less time has caused the production of better rolling stock, more solid roadbed, the elimination of curves, the installation of finer signal systems and greater care on the part of the employes, yet with all these there are frequent wrecks.

It may be as shown above, that a train will jump a track and go into the ditch leaving the line practically clear but generally there is so much debris that all other traffic is entirely obstructed.

The instant the news is received of a wreck on a division of road every one on that section especially is on the jump to assist directly or indirectly in the wreck itself [illegible] and [illegible] in the business of the road [illegible] wreckage is being cleared and the line opened.

This is especially true of the single track roads and even a double

ONE OF THE HEAVY RAILROAD CRANES SENT TO PANAMA.

Built by the Bucyrus Co., South Milwaukee

track may be badly covered, but then two tracks in each direction are available.

The first call from a wreck is for transportation, to get the injured and saved away and to gather up the debris. With this call comes one for doctors, food and other things for the comfort of the people at the wreck if it has been one of a passenger train. A gang of men and a thoroughly equipped train with all appliances for hoisting are the first to be sent to the wreck and the hoisting end of the equipment is at the head of the train.

Railroads vie with each other in having in use the very latest devices known for the safety and comfort of their patrons and when a wreck occurs, hurry all possible aid and improved machinery to the scene. A most perfect organization in the wreck clearing crew is maintained and everything is done to assure the impatient passengers of speedy continuance of their journey.

The "Wrecking Crew," as it is so often called, more rightly the "Wreck Clearing Crew," belong to an organization consisting of a general wrecking master, who reports to the master car builder and under whose immediate charge are a complete heavy clearing outfit at the principal division points of the system and whose duty it is to know that all cranes, cars with extra equipment are in perfect condition and always ready for action. He also goes to wrecks of any magnitude and takes personal charge, directing the men and the placing of machines for clearing the track and the disposal of property. He is assisted by a wreck master in charge of each of the different outfits at division points who in turn is responsible for the proper care and handling of these and who has an engineer in charge of the steam crane, an assistant engineer and from six to ten men as riggers and laborers. These men are regularly employed in other departments when not out at a wreck and by a system of calls they can be collected in a very short time. The local wreck master has the choosing of his men and is responsible for their efficiency. Such is the promptness of response that after the call is received the crew is ready to leave headquarters in half an hour at night and one half that time in the day.

Mr. A. M. Clough, Supervisor of construction of West Shore R. R., says that a notable performance of this way of calling was once noticed. The whistle sounded to assemble at 6:48 a. m., and almost instantly a switch engine backed up to the wreck clearing train and placed it out on the main line, an engine standing ready on a way freight was detached and placed on this train, and the conductor and brakeman just shifted from one to the other and at exactly 7:00 o'clock the wreck clearing train pulled out of the yard with its full equipment.

Three cars beside the crane usually compose the train, one for jacks, tackle and rope, one with trucks and wheels ready for cars that need them and the third in which the crew sleep and eat. Here is maintained an elaborate commissary department where not only their own crew is fed but often in long, difficult cases all men employed in the work are cared for, generally in installments.

To keep pace with the enormous advance in motive power and other rolling stock [illegible] of cranes and character of other equipment show [illegible] the wrecking was [illegible] and tumbled [illegible] picked up and replaced with as little further damage as possible.

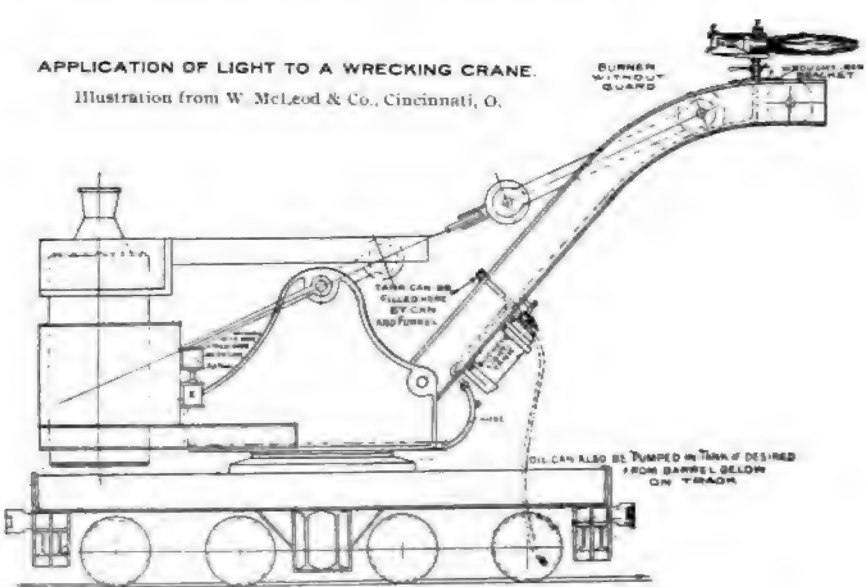
The [illegible] of crane [illegible] generally used may be described as a short [illegible] track [illegible] capable of lifting and swing-

DRAGGING A LOCOMOTIVE UP A RIVER BANK.

READY TO SET A LOCOMOTIVE ON ITS WHEELS.
Two cranes of the Industrial Works, Bay City, Mich.

ing at about 20 foot radius a weight of 75 to 100 tons. When used for extreme lifts the crane is secured by means of rail clamps and out riggers, the latter really adding base or footing space and thereby giving greater stability. It will be seen that all the chains, ropes, etc., must measure up to the capacity of this giant and the rigger who places them in position must be an experienced man. In the design of the crane, the steel frame car with double truck is universal and the underwork must be such that will facilitate its rapid dispatch over the roadbeds and bridges. The design is limited in several features, its weight per lineal foot upon the roadbed or bridge over which it must be transferred, must not exceed the bridge engineer's designs. The clearance dimensions must be the same as other rolling stock and fast running-in trains as well as quick operation are modern necessities. The car body should be equipped with standard air brake and draft rigging and the couplers must be of proper height and approved design.

A crane with a lifting capacity of 60 tons at a radius of 16 feet will have in working order, a weight approximately of 75 tons, which is distributed over a wheel base of 17 feet 6 inches. Of course it would be economy to keep such large machines in active service and these cranes are used for a variety of purposes, such as bridge work, handling heavy objects in the yards of the main shops, etc. If built self-propelling, the attachments should be so arranged that this mechanism may be disen-



APPLICATION OF LIGHT TO A WRECKING CRANE.
Illustration from W. McLeod & Co., Cincinnati, O.

gaged for rapid transportation in trains. In car lifting particularly the effectiveness of a crane depends upon the sufficiency of boom radius, so that cars may be lifted in any boom position without interfering with the car frame of the crane itself. It would be impracticable to mount a crane with a very long boom upon a crane car, if large capacity was expected. Such a crane would be very unstable although the car might be of great weight. In many designs the standard boom radius has been selected at about 20 feet and means for increasing or decreasing provided to adapt it to particular service.

The engines operating the crane are double and fitted with best metal gearing. Flexible wire rope is used for hoisting and there is sufficient length on the drum, when the block is detached and single line used, to allow the hook to reach twice the boom length from the crane. The boilers are of the vertical submerged flue type and are provided with proper jackets and with the best designs of fittings for service. Injectors of sufficient capacity are used on these boilers, but are different styles so that an engineer need be posted on the operation of any make.

The differences in the makes of cranes in this country are mainly in the workmanship, the designs being quite alike, and are similar to those from foreign shops.

A disagreeable feature of wreck clearing at night is the lack of proper lighting facilities and the diagram here given shows the application of the oil-burning lamp to the crane. The arrangement is the conception of railway officials and fulfills a convenience which is much appreciated as a light is always present in the direction in which the boom is working.

THE WRECKING CREW.

By Stanley Huntley Lewis.

EASTWARD and West, 'twixt plain and crest,
Stretch far the iron bands ;
Gloomy and black, beside the track
The silent bunk-house stands.
Within, the glow of lights turned low—
Faint pipe-smoke curling blue,
Their vigil keep—while others sleep—
The tireless Wrecking Crew.

A square of light, gleams thro' the night,
The lone dispatcher's pane
O'er the wide yard, with switch-lights starred,
And freight sheds, grim and plain ;
While close below, in shroud of snow,
Looming ghost-like to view,
The black-bulked crane and three-car train
Awaits the Wrecking Crew.

O'er the iron trail the 'Frisco Mail
Bores thro' the blinding sleet ;
And hour by hour, up in his tower
Despatcher cons his "sheet."
By grade and glen, the Mountain Men,
With hearts so stanch and true,
Face fickle Fate, while silent wait
The ready Wrecking Crew.

"Double-head Nine from Blasted Pine"—
The rattling "sounder" clicks;
"Hold Twenty west at Eagle Crest
For First and Second Six!
Four-ninety stopped--(her crown-sheet dropped)—
Now here's a howd'ye-do!
Water too low—he'll need a tow,
Perchance the Wrecking Crew!"

"Ten days off, sure, for Bill McClure"—
Then "orders" quick begin—
"Twenty must stop at Mountain Top
And bring Four-ninety in!"
Light as a breeze, across the keys
His nimble fingers flew—
"God! Wilson's ditched at Foster's Switch—
Get out the Wrecking Crew!"

With snow-piled prow, an engine now
Swings out upon the "main";
With rapid thump, the sobbing pump
Is "charging up" the train.
The clanging bell—the caller's yell—
"All aboard! Hustle, you!"
The swift "high-ball"—the whistle's call—
Here goes the Wrecking Crew!

In clouds of black from out the stack
The flame-shot smoke is streaming.
At every swerve a stubborn curve
Echoes the flanges' screaming.
On thro' the night, and still in spite
Of swing and sway and slew,
From pilot bar to cabin car
Cling fast the Wrecking Crew.

With vision clear, the engineer
Leans o'er his elbow rest,
The urgent need for furious speed
Is ever manifest.
Thro' clouds of steam he's vaguely seen,
With greasy cap askew—
The man whose brain directs the train
That bears the Wrecking Crew.

* * * *

Far up the line a train of kine
Is scattered down the bank;
With staring eyes the fireman lies
Fast-pinned beneath his "tank";

The flames roll near—from pain and fear
His face is gray of hue;
In vain we lift—must death more swift
Forestall the Wrecking Crew?

Hark! thin and clear, yet drawing near,
A whistle's blast resounding;
Thro' rocky walls there echoing falls
An exhaust's steady pounding.
See! thro' the night, a point of light,
A headlight swings to view—
As up the grade they speed to aid—
The gallant Wrecking Crew!

Thro' iron sheaves, with ponderous heaves,
Shudders the creaking chain;
And in its slings the tender swings
A dangle from the crane;
While truck and wheel and twisted steel
The "right-of-way" bestrew,
While tender hands the injured man's
Borne by the Wrecking Crew.

They've cleared the track—now speeding back,
The huge "consolidation"
On Mercy's wings the suff'rer brings
Swift to the nearest station;
Beside the gates the ambulance waits—
The railroad doctor, too,
His verdict gives, "The man will live,
Thanks to the Wrecking Crew!"

* * * *

Your bards may sing of the men who bring
Their trains from the East and West—
The chances they take at throttle and brake
Prove their mettle—the bravest and best;
They've earned their glory in song and story,
But I'll tune my lyre anew
For the lads o' the train with the Giant Crane—
A health to the Wrecking Crew!

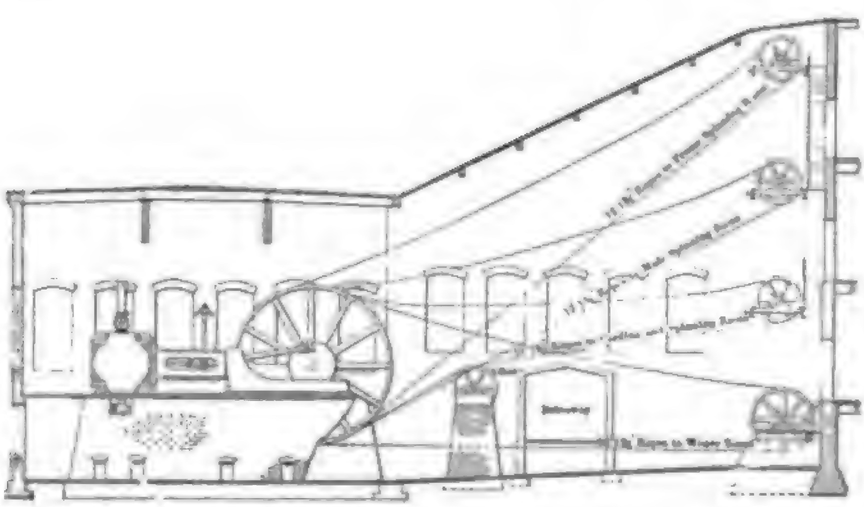
—Written for The Railroad Man's Magazine

The Transmission of Power by Ropes.

BY F. W. HACKSTAFF, M. E.

THIS form of power transmission was first introduced in England and Ireland, and was not used in this country to any extent for a number of years. In fact as late as 1900 there were comparatively few drives of this character in the U. S.

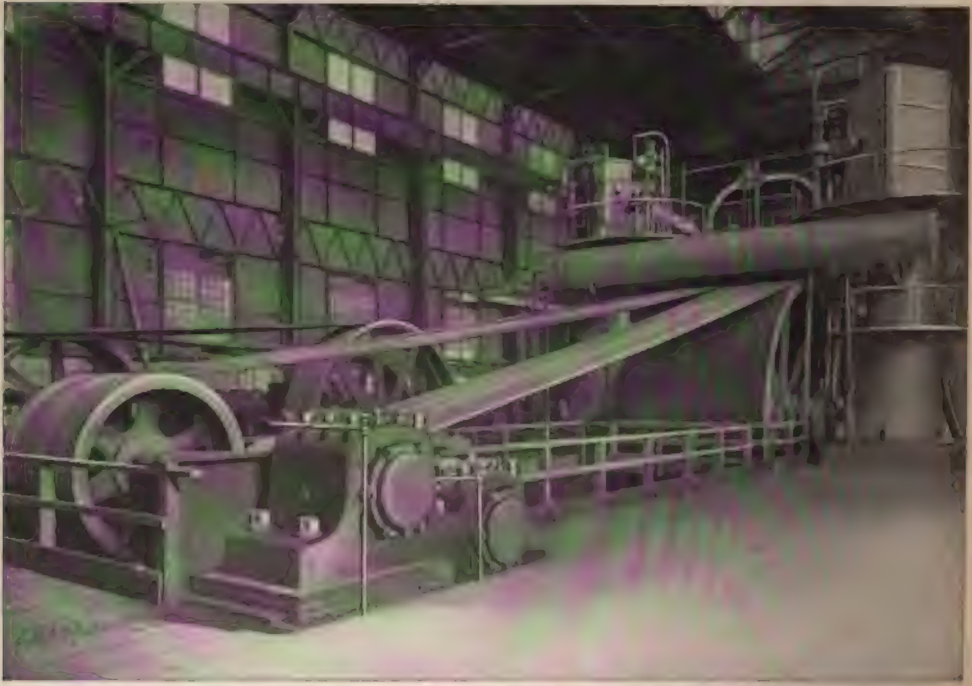
To-day rope driving stands on an equal footing with belting and electrical transmission. It first gained a firm foot hold in this country in the grain elevators along the Great Lakes, and from the immediate and marked success of the system in these plants, manufacturers of the Middle West in other lines began adopting rope drives rapidly. From the grain elevators they found their way into the kindred industry—flour mills—where they proved so satisfactory that they were gradually installed by the cement manufacturing plants and pulp and paper mills, where, on account of the dampness always prevalent and so destructive to belts, the ropes gave perfect satisfaction and increased saving in first cost and maintenance charges. At the present time we find large rope drives in nearly every cotton mill in the South and there have been a great many installed in New England during the past five years.



Main Engine Drive, Whitman Mills, New Bedford, Mass. Designed by C. R. Makepeace & Co.

If there is one place above all others where rope driving predominates over either belt drives or electricity it is in textile plants, and especially in the modern cotton mill. Here it is usually installed from the main engine—the multiple, or so call "English" system being used; from twenty to thirty ropes are upon the driving wheel, and should the mill be three or four stories, each floor takes direct from the engine to the line shaft, a sufficient number of ropes to drive the machinery upon that floor, counter driving, with the accompanying waste of power, being done away with to a great extent.

The application of rope driving to iron rolling mills is of much interest and has met with marked success in almost every installation. The ultimate power necessary to carry the great masses of heated metal through the rolls until they are reduced to the required shape and dimensions and how to provide against breakdowns due to excessive vibrations from shocks and stresses, are issues with which only the iron and steel men are familiar. This was first accomplished by either belting or gears, but to-day ropes are used and everywhere their installation is attended by great economy and increased output.



Main Engine Drive of the Pittsburgh Steel Co. Twenty 2" diameter Manilla ropes to shaft running 240 R.P.M. Thirty-six 1 1/2" diam. Manilla ropes to shaft running 450 R.P.M. Total H.P. 2600. Speed of rope 7000 ft. per min.

Sharon Steel Company's 3200 H.P. drive. Sixty 2" diam. Manilla transmission ropes.

Drives of great magnitude using a number of large ropes were installed as shown by the accompanying cut, showing a drive required to transmit 3200 H. P. by means of 60 2-in. dia. Manilla transmission ropes. A similar drive is to be found at New Castle, Pa., and large powered drives are very common throughout the Pittsburg district.

Below are given some of the most pronounced advantages which are causing engineers everywhere to recognize the superority of the system.

1. The distance and direction in which power may be transmitted is practically unlimited. Satisfactory driving may be done where the distance between shafts is as great as 80 to 90 feet, without the aid of carrying pulleys, while with such carriers the distance may be prolonged almost indefinitely. On the other hand successful driving can be done with ropes where the shafts are close together. There are in operation many drives whose sheaves are but 10 ft. or even less center to center. Where shafts are neither in the same line or plane, by properly placed guide sheaves power may be transmitted around corners from one building to another, and in short between any two shafts in whatever relative position they may be.

2. The amount of power which may be transmitted is also practically unlimited. There are a number of drives in this country which are transmitting from 2000 to 4000 H. P. with perfect satisfaction, a good example being the main engine drive of the Pittsburg Steel Co., as shown in accompanying cut.

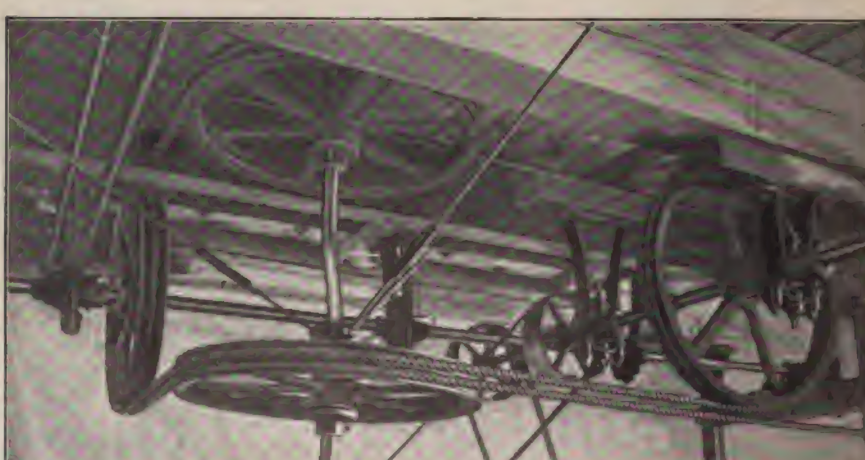
3. Economy in first cost and maintenance. In drives of 200 H. P. and up, where the shafts are more than 30 ft. c. c., the cost as compared with belts will vary from 15 to 50 per cent in favor of ropes, according to the distance and size of drive This advantage increases rapidly as the distance apart of shafts and amount of power transmitted increases.

The small cost of maintenance of a rope drive is a strong point in its favor. The average life of rope on a properly designed drive is from three to eight years, and during this time the only care it requires is correct splicing, and a "run" free from obstructions, for a properly constructed transmission rope needs no external dressing whatsoever.

4. Economy of space. The width of rim surface required in rope drives is only from one-half to two-thirds that required for belting, varying with size of rope used It follows, therefore, that the supporting bearings may be placed nearer together for a rope than for a belt drive, an advantage that the practical mill man will recognize as of first importance.

5. Positive and steady running. The elasticity of the rope, its light weight and slackness between pulleys take up inequalities in power and load, thereby producing more positive and regular running than exists in any other system of power transmission.

6. Rope drives are noiseless, a fact due to the flexibility and lubrication of the rope, and to the air passage in the grove, between it and the sheave. Another advantage which may be mentioned is that no electrical



40 H. P. Angle Drive through 16" I-beam.

disturbance is produced, which is a distinct advantage especially noticeable in textile mills, where such disturbances, caused by belts, are the greatest source of annoyance.

7. No loss by slipping. In properly designed rope drives, where diameters of the pulleys are sufficiently large and angle of groove correctly turned, loss of power by slipping becomes so infinitesimal that no allowance should be made when calculating speed for driven shaft.

8. Precise alignment of shafting not necessary. When shafts are at an angle with each other, by properly placed guide pulleys, power may be transmitted by ropes to great advantage, and where shafting is slightly out of line, unless the imperfection is too pronounced, the rope will follow the grooves of the sheave even without the use of an idler.

Future additions to power may be readily taken care of by installing sheaves with extra grooves, and adding new ropes when additional power is required.

The so called disadvantages of rope driving are no more serious than are those peculiar to belt or other transmissions. The conditions under which this system has been installed have been so varied, and, in many instances, with flagrant disregard to the fundamental principle of mechanics, that it is no surprise to hear of occasional dissatisfaction, but it is safe to say that an investigation of these failures will invariably show either faulty design, careless treatment, or above all bad splicing. For well proportioned rope sheaves, properly turned grooves, and a good transmission rope from a combination which is hard to surpass.

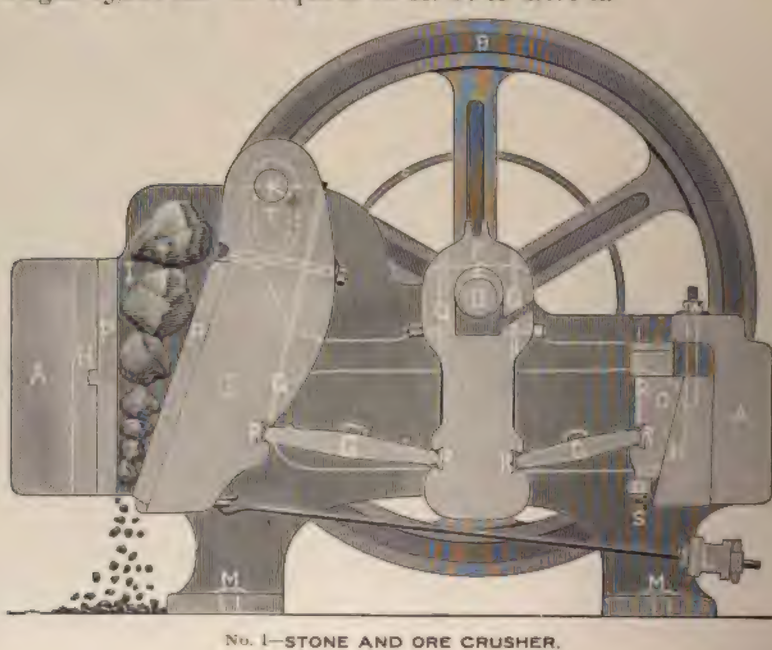
The Manufacture of Plaster of Paris or Stucco from Gypsum Rock.

BY C. O. BARTLETT.

GYPSUM ROCK is found in many States throughout the Union in large quantities and near the surface. It varies somewhat in color and considerably in hardness. The most of it is quite hard. It contains about 25 per cent moisture.

Plaster of Paris is generally called calcined plaster, and in this article the term calcined plaster will be used hereafter. The manufacture of calcined plaster has increased very rapidly during the last few years. It is the base of all ready made plaster, and is used in the manufacture of Portland Cement and in many other places. The demand for it is increasing rapidly. To manufacture this gypsum rock into calcined plaster, in quantities of fifty tons a day of ten hours, the following machinery, with weight, H. P., etc., is required:

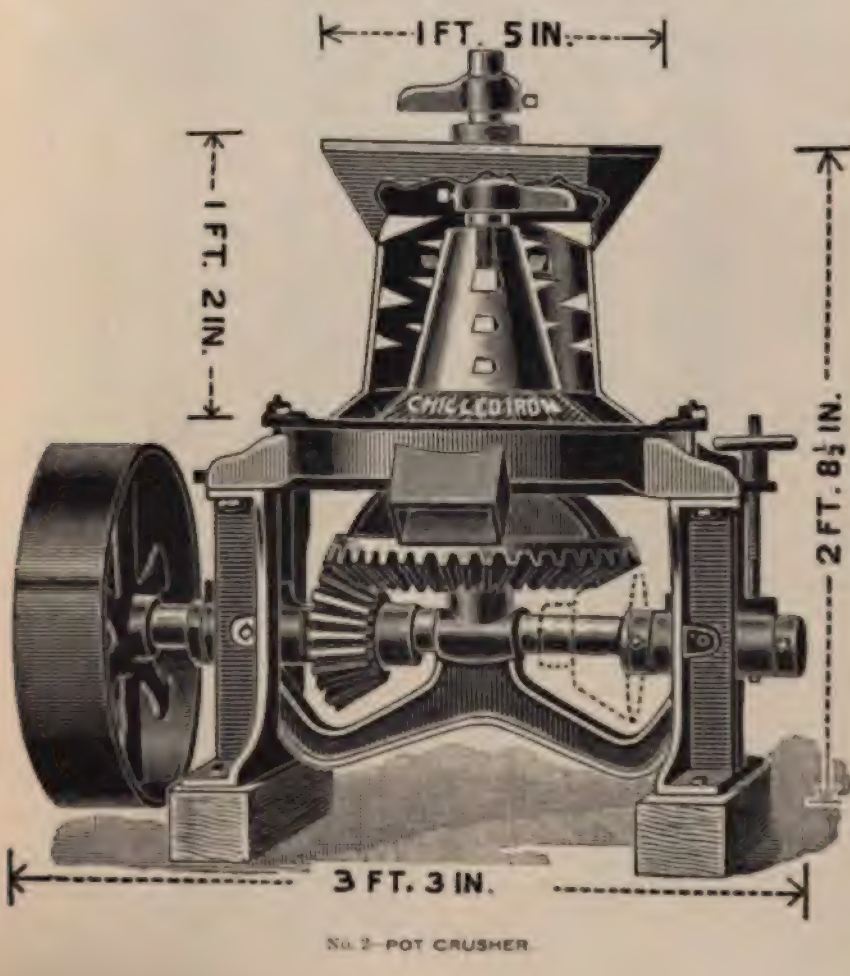
The gypsum is first crushed in a jaw crusher (cut No. 1). The crusher has an opening 9 in. x 15 in., and will crush five tons an hour. It weighs 15,000 lbs. It requires 10 H. P. to drive it.



No. 1—STONE AND ORE CRUSHER.

From this crusher the crushed gypsum rock goes to the second crusher, called a pot crusher (cut No. 2), and is again crushed. Weight of this crusher is 3,500 pounds. Power to drive it 10 H. P.

From the second crusher the material goes to the dryer (cut No. 3). Weight of the dryer 21,000 lbs. It requires 8 H. P. to drive the dryer, including exhaust fan. This dryer should be erected in brickwork similar to a boiler. The products of the fire should not come in contact with the material on account of the danger of coloring it, if soft coal or wood is used as fuel. In some places, however, the products of the fire are allowed to come in contact with the material even when coal is used for fuel. Where this is done great care should be used in firing, and



No. 2—POT CRUSHER

No. 3—CYLINDER ROTARY DRYER.

No. 4—GRADING REEL.

on general principles it is better not to have the fire come in contact with the material at all, if coal or wood is used as fuel. Any kind of fuel can be used, oil, gas, coke, wood or coal. Ten per cent of the moisture is taken out in the dryer. The dryer should have an automatic feeder.

From the dryer the crushed rock goes to the reel (cut No. 4), 36 in. in diameter and 12 ft. long, clothed with 24 mesh wire and ¼ mesh wire. That which passes through the 24 mesh goes to the bins over the kettle. The balance goes to the bins over the grinding mills (cut No 5). Mills to have solid French buhr stones with iron frames. Stones are very heavy, 8 in. in thickness and 36 in. in diameter. Weight of the mills five tons. It requires 35 H. P. to drive them. The product from the stones should pass to bins over the kettle. The ground gypsum is now ready for boiling.

The boiling is done in a large kettle 10 ft. in diameter and 10 ft. deep (cut No. 6). Weight 10 tons. It requires 25 H. P. to drive it. It is constructed as follows:

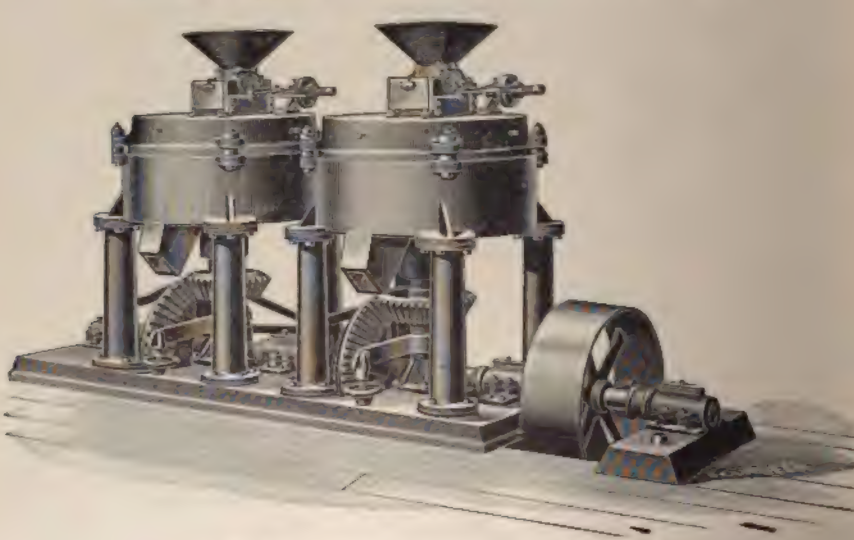
The ground gypsum is fed into the kettle and continually stirred and boiled until the balance of the free water is evaporated. It usually takes about two hours to boil one batch. It should be brought to a temperature not to exceed 265 degrees F. When properly boiled it will settle, and is ready to be discharged. This is done through a discharge gate on the side near the bottom, said gate being operated with a lever

from above. This is the first boiling or settling. A very large proportion of the calcined plaster is used in this form. If it is desired to make a finer grade it is necessary to boil it the second time, which is in reality to take out the water of crystalization. If this water of crystalization is once started it must be taken out, otherwise the calcined plaster will be spoiled. Therefore it is important not to get the temperature above 265 degrees in the first boiling, and from 390 to 395 in the second boiling. Considerable care must be taken with the boiling of the material, for here is where the chemical action takes place. After the material has been boiled it should be bolted again with a reel (cut No. 4) clothed with 40 mesh. The tailings from this reel should then be ground on a 24 in. French buhr mill (cut No. 7).

In addition to the above named machinery the neccessary elevators, conveyors, shafting, belting, bins, etc., will be required. On account of the nature of the material the bins, conveyors and elevators should be made of steel, and elevators and conveyors should have steel casings. Estimated weight of elevators, conveyors, etc., 10 tons. Power to drive them 25 H. P.

To manufacture ready made plaster or ready mixed plaster the calcined plaster is used as the base. It is mixed with sand, hair and retarder, or wood fiber and retarder, in the following proportions for wall plaster:

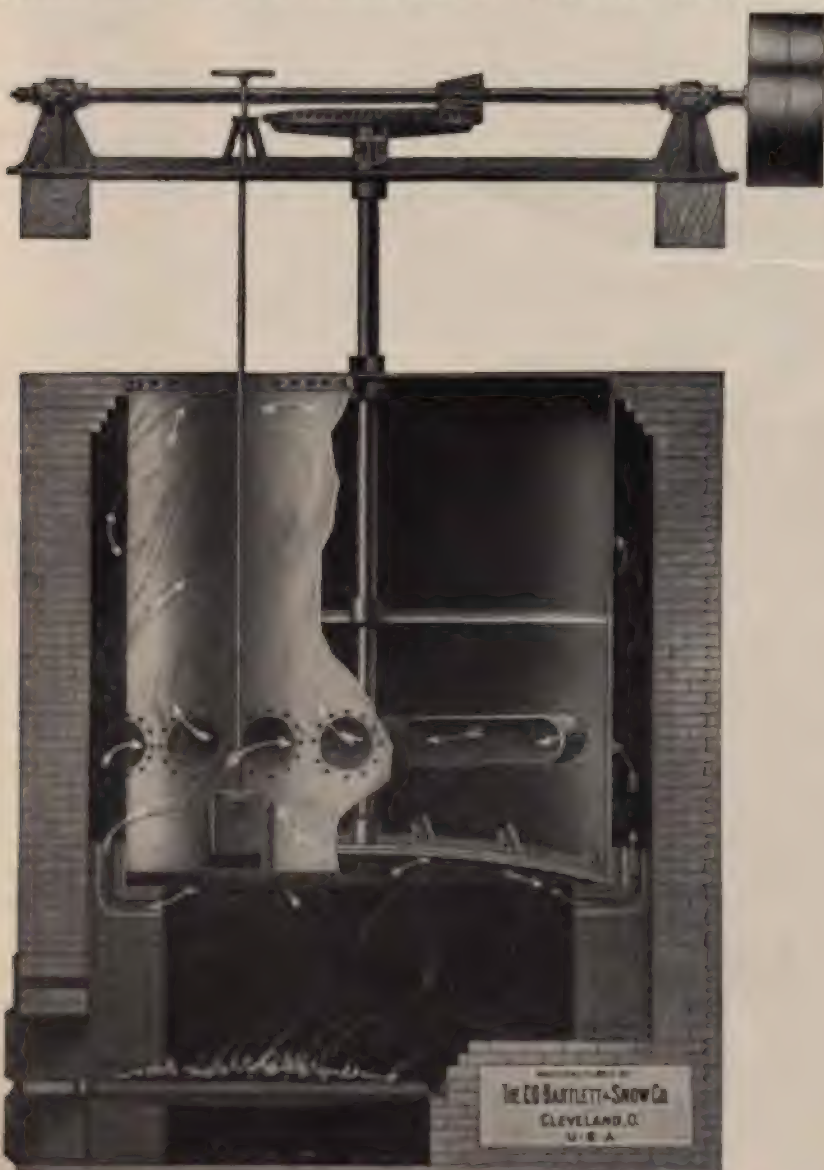
Calcined plaster	300 lbs.
Goat hair (about)	1 lb.



No. 5—HORIZONTAL FRENCH BUHR MILLS.

Dried sand	600 lbs.
Retarder, from 1½ to......................	2 lbs.

If desired hydrated lime can be used, and if so one-third as much hydrated lime as there is calcined plaster. Also about two pounds of



No. 6—CALCINING KETTLE.

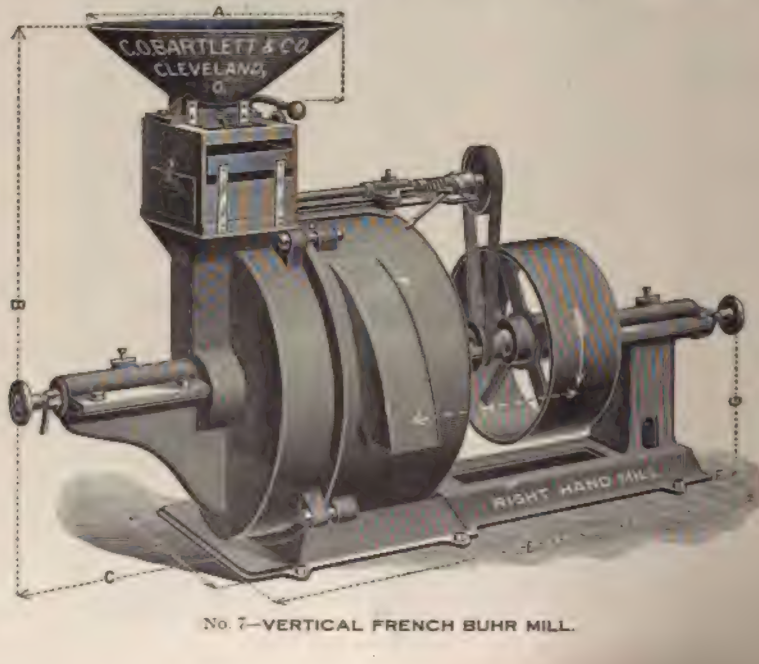
asbestos fiber can be used to good advantage, and sometimes adds considerable to the working of it. For sand mortar and brick walls 300 lbs. of calcined plaster and 900 pounds of dried sand is used; no hair is necessary. There must be either all calcined plater and sand, or calcined plaster part and hydrated lime part and the balance sand, in proportion of one part calcined plaster to two parts of sand for lime mortar, and one part calcined plaster to three parts sand in brick mortar.

Wood fiber is largely used for ready made wall plaster, and is one of the best fillers known in plaster work. It makes the plaster elastic, the weight of it is much less, and it also helps to make it sound proof and electricity proof. The following is a good formula when wood fiber is used:

Calcined plaster	600 lbs.
Clay	500 lbs.
Wood Fiber	40 lbs.
Retarder, from 3 to	5 lbs.

The color of the clay makes no particular difference, as a white coat usually follows. Some manufacturers use a low grade cement, and add as much as 200 lbs. of this to the above formula.

Wood fiber can be made of almost any kind of soft wood. It is made as follows: First, the wood is cut into lengths to suit the ma-



No. 7—VERTICAL FRENCH BUHR MILL.

No. 8—FIBRE MACHINE.

chine (cut No. 8), usually about 2 ft. long and about 24 in. in diameter. The block is placed in the carriage between centers and caused to revolve around the shortest diameter. The saws are set on a bias, and revolve very rapidly, so that instead of cutting directly into the wood they make it into fibrous material, each piece being from ½ in. to 1½ in. long, according to the fineness of the material desired. This machine weighs 2000 lbs. It requires 15 H. P. to run it.

The proportion of materials in making ready made plaster can be varied according the demand of the architect and the purpose for which according ot t hfieneness of the material desired. This machine weighs it is used. Quite large quantities of hemp or old rope were formerly used, but are not use much at the present time. Calcined plaster is the base of all hard plaster, and without it hard plaster cannot well be made. The retarder is used to prevent the quick setting of the plaster. It retards it. This is manufactured in several places, and can be bought for $45.00 a ton. In making a good quality of ready made plaster it is very important to either weigh or measure the material carefully. No guessing should be allowed. It is also very important to thoroughly mix the material, and the batch mixer is always recommended.

Coal Storage Pits at Hawthorne.

AFTER carefully investigating the question regarding the uncertainty of the coal supply, due to strikes and other conditions beyond the control of the manufacturer, The Western Electric Co., at Hawthorne, Ill., decided to follow the practice adopted by the British Admiralty.

LOCOMOTIVE CRANE HANDLING COAL FROM STORAGE POCKETS.

OLD STORAGE POCKETS ADJOINING BOILER ROOM. USED FOR COKE WHEN EMPTY

FIRST BAY SHOWING CONCRETE ARCH CONSTRUCTION. NOTE EASE OF UNLOADING

SHOWING TOTAL AREA OF STORAGE POCKETS, LOOKING NORTH.

ELEVATED SPUR TRACK INTO BOILER ROOM.
Full car loads are dumped into bins of 1,000 tons capacity.

One large storage pit 310 feet long, 114 feet wide and about 15 feet below the normal ground level has been erected.

It is divided into twelve sections, each section having a capacity of 1000 tons, making a total of 12,000 tons, allowing forty pounds of coal per cubic foot.

Three railroad tracks are built up on concrete piers running the entire length of the pit, so the coal may be dumped from cars into it and taken out by means of a locomotive crane fitted with a grab bucket.

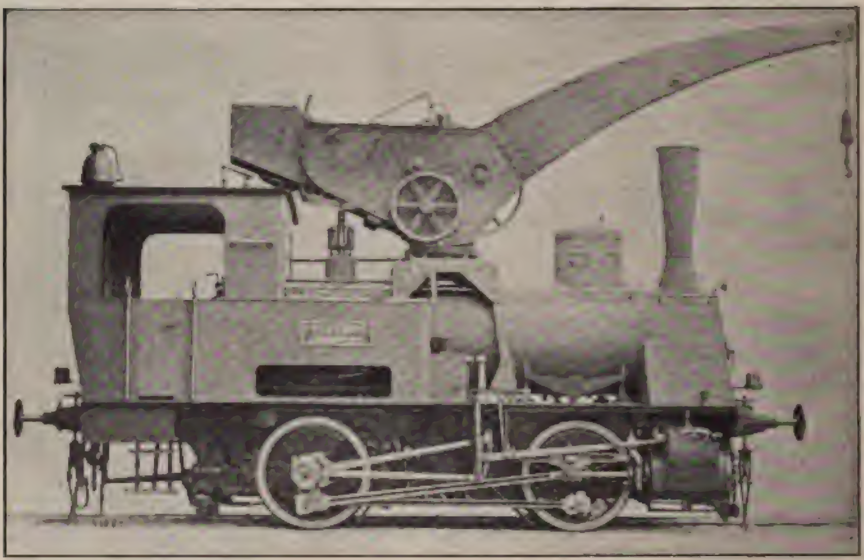
The pit is constructed of concrete, one, three, five mixture of Portland cement, Torpedo sand and crushed limestone. Executed tests in Europe show that nearly 30 per cent of the heating value of coal is lost in six weeks, when exposed to the air. By keeping the pits flooded the company expects to reduce the losses of the coal to approximately 2 per cent of its heating value after six months to a year storage; the result of this feature will be carefully watched with interest.

An Unique German Locomotive Crane.

BY FRANK C. PERKINS.

A NEW German locomotive crane for construction work is shown in the accompanying illustration, also for use in iron and steel plants, and large manufacturing works. This 3,000 kilogram locomotive crane is in operation at the Germania No. 1 plant of Fried. Krupp, and was constructed by the Maschinenfabrik Esslingen at Esslingen, Germany. It was constructed for use on a standard gauge track and is equipped with cylinders 330 millimeters in diameter with a stroke of 550 millimeters. The cylinders are supplied with steam at a normal pressure of 12 atmospheres from a boiler having a total heating surface of 58.65 square meters. The boiler is provided with 115 tubes having a diameter of 45 millimeters and three meters in length. The total heating surface of these tubes is 54.85 square meters while the heating surface of the fire box is 3.8 square meters. The firebox of this boiler is 1,002 millimeters in length 935 millimeters in height, and 853 millimeters in breadth. The grate area is .910 square meters.

The total weight of the engine with crane is 28.08 tons when provided with water and fuel and ready for service, while the weight empty is 23.76 tons. A tender is provided having a fuel capacity of 5 tons of coal and a water capacity of 1.885 tons.



A GERMAN LOCOMOTIVE CRANE.

The locomotive crane shown in the accompanying illustration has a total wheel base of 2.5 meters, the four coupled wheels each having a diameter of 1.08. These driving axles support 13.9 tons and 14.18 tons respectively for the forward and rear axles. The crane is mounted on the top of the locomotive as noted in the accompanying photographs, and is operated by a steam engine mounted on the crane and supplied with steam from the locomotive. The hoisting, slowing, and all of the movements of the crane and locomotive are controlled from the cab by the engineer without the slightest difficulty, the levers and controlling wheel being in a position such that the operator can note the position of the work which is being raised and otherwise handled, while controlling the steam to the hoisting engine as well as the locomotive cylinders.

Coal Storage for Retail Yard.

By J. D. Mooney.

THE Wabash Coal Elevator Co. is just completing the construction of a retail coal plant for the Wabash Railroad terminal at Cleveland, Ohio. The plant was designed by L. A. Holeman, of Cleveland, and the construction has been under the superintendence of B. F. Courtright. The coal is taken from the railroad cars up to storage bins which are on the level with the surrounding streets. From these bins the coal is let into the retail wagons.

Fig. 1—GENERAL VIEW OF PLANT

Coal Dump in Pit at Base of Hill

Fig. 2—SHOWING CHUTES TO WAGONS.
These are on Opposite Side from Conveyor.

A general view of the plant with its bucket conveyor is shown in Fig. 1. The storage capacity is 1700 tons, afforded by a series of seventeen 100-ton bins. These bins are not beveled toward the chute pocket on the inside, but the coal is left to form a bevel of its own. In case of a sudden shortage of coal, men could be sent into the bins to shovel down the coal forming the bevel. The coal bevel thus forms kind of a reserve stock. The bins are 16′ x 20′ and 16′ high.

The coal is first delivered into a concrete pit at the bottom of the bucket conveyor. The loaded car is pushed onto a 43-foot track scale over the pit, weighed, unloaded into the pit, and weighed empty to get the net weight. This concrete receiving pit is 16′ deep, and tapers from 18′ x 10′ at the top to 11′-6″ x 10′ at the bottom. A No. 200 Rose straight-bucket conveyor receives the coal from the pit. This conveyor runs up at an angle of 68°-20′ to the horizontal, and is 100 feet long from center to center of shafts. Each bucket carries about 450 pounds.

At the top of the incline the coal is delivered to a long and short arm distance carrier, which takes it to the various bins. Fig. 3 is a view of one end of this carrier taken at the top of the bucket conveyor. The coal is carried along by arms of this carrier, and the supply for each bin

Fig. 3—VIEW OF ONE END OF CONVEYOR.

Buckets Dump to Bins over Wagons.

is regulated by a piece of sheet iron sliding over a hole in the top of the bin.

Pocket chutes deliver the coal to the wagon. The flow of coal is regulated with a slide door operated up and down by means of a rack and pinion. The driver can operate the door from his seat by turning a 16" hand wheel. The spout and chute bottom are lined with $\frac{1}{8}$" to $\frac{3}{16}$" sheet iron. Fig. 2 shows the arrangement of some of these chutes. These are on the opposite side of the bins to the bucket conveyor.

The plant is to be operated by a 55 horse power steam engine, and will be lighted by electricity. The entire structure is built on made ground, and the columns are set on concrete piers.

INDUSTRIAL PROGRESS.

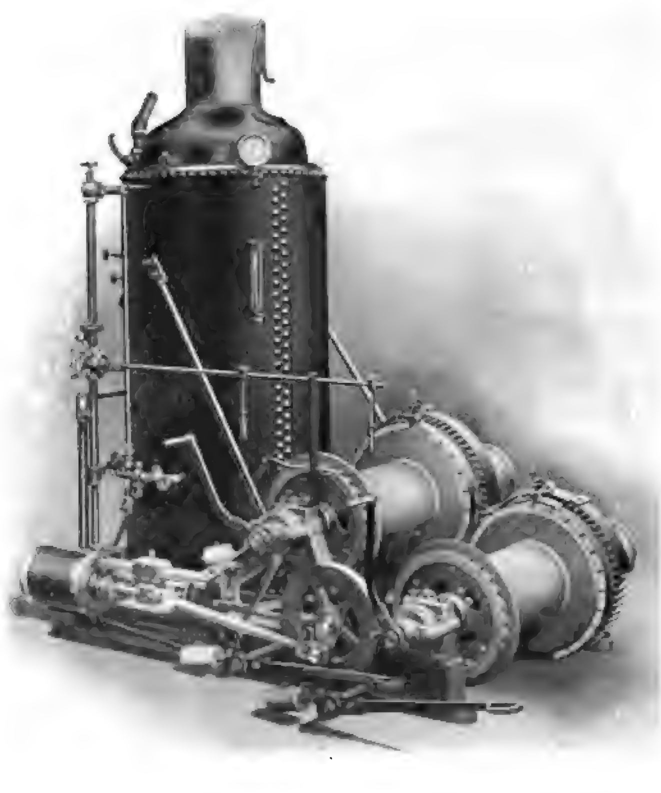
Improved Hoisting Machinery.

BY WALTER MUELLER.

THE point which the contractor considers most in purchasing hoisting machinery is dependability, due to the fact that so large a proportion is of necessity often operated at a considerable distance from available sources of supply; in addition to which it is, as a rule, run by more or less unskilled labor. On account of this, the question of breakdowns becomes a momentous one, for the reason that when a breakdown occurs, it is not only going to delay the work, but, in many cases, cause a considerable financial loss as well.

Although breakdowns cannot, of course, be absolutely guarded against even in the best constructed types of machinery, still their effects can be reduced down to a minimum. Where hoisting machinery is built on what is known as the duplicate part system, a breakdown loses much of its terror. Duplicate parts can be either immediately secured from the manufacturer by wire or telephone or they can be carried along with the outfit, depending upon where operations are being carried on. Of course, where the machinery is being employed within easy reach of its manufacturers, the latter course is unnecessary.

The contractor's plant is of necessity rather of an unstable nature. He may be engaged on



LIDGERWOOD DOUBLE DRUM ENGINE WITH BOILER.

LIDGERWOOD DOUBLE DRUM ENGINE,
with boiler and No. 4 boom swinging gear.

a certain large undertaking requiring a considerable amount of machinery. After this undertaking has been carried to a successful conclusion, the contractor, in many instances, finds himself with a lot of machinery on his hands for which he may not have any immediate use. This machinery naturally assumes the nature of a white elephant and the question of disposing of it without loss becomes a pressing one.

Therefore, in buying machinery, the contractor must take into consideration what it is going to bring at second-hand. While a certain piece of machinery when new may cost more than another of a similar type, its second-hand selling price will be so much larger than that of the other that the original first-cost becomes of minor importance. It is therefore almost axiomatic to state that that piece of machinery between whose first cost and second-hand selling price there is the least difference is the most economical one for the contractor to use.

A type of hoisting machinery conforming with all of the above requirements and whose favor among contractors is attested by the fact that over 27,000 of them are at present in use all over the world is that manufactured by the Lidgerwood Manufacturing Company, of New York. It may be of interest to learn that this company was incorporated in 1873 and was practically the continuation of the Speedwell Iron Works of Morristown, N. J., established in 1802 by Judge Stephen Vail, stepfather of William V. V. Lidgerwood and John H. Lidgerwood.

In these works much of the most important engineering work of the early part of the last century was done. A most notable achievement was the design, construction, and operation of the electric telegraph. One of the Speedwell shops was utilized for this purpose —several miles of wire being strung around the inside. Prof. Morse and Alfred Vail jointly accomplished this work—the latter inventing the alphabet now generally used. The machinery for the steamship "Savannah"—the first steamship to cross the Atlantic—as well as the first machine for planing iron, were also built in these works.

The Lidgerwood Manufacturing Company is the only concern in the world that builds

all kinds of hoisting engines upon the duplicate part system, and that makes a large enough quantity of engines to enable them to do so. All parts are made of standard gauges and templates in large quantities. This not only insures the absolute accuracy of the various parts but makes all like parts interchangeable on the various types of engines, besides guaranteeing the absolute standard quality of workmanship.

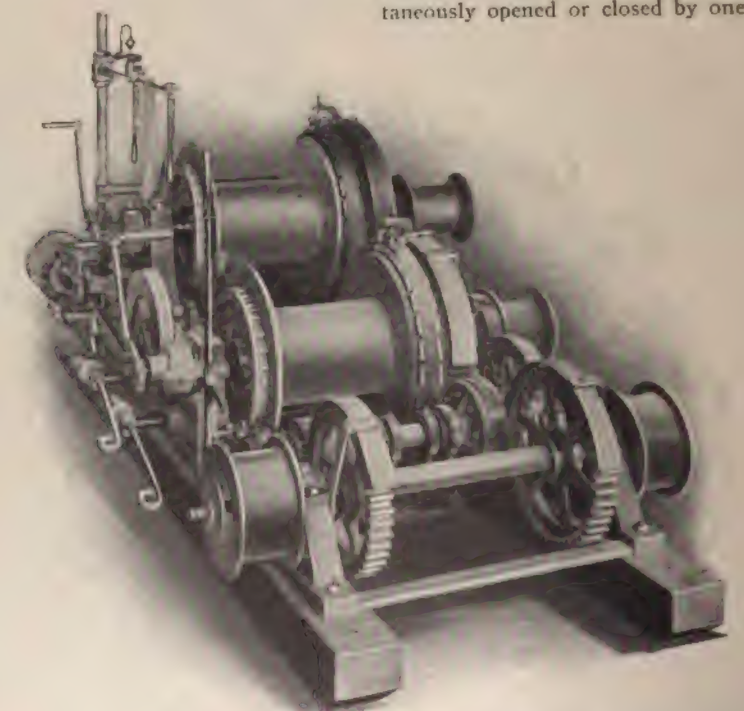
By this system a large number of the various parts is necessarily kept in stock and the company is enabled to make very quick shipments, it being merely necessary to assemble the various parts in the erecting shop and combine them into a complete machine. As the company's workmen are employed upon the same parts year after year they become extraordinarily expert in their manufacture, thus enabling the Lidgerwood company to furnish the highest grade of engine at a moderate price.

A type of hoisting engine which is extensively used for all kinds of building construction is that shown in the illustrations on pages 623 and 626, the Lidgerwood double drum engine.

This engine is of the most approved type for use in general hoisting where two independent drums are required. It is of the Lidgerwood standard double cylinder type, quick in starting with a heavy load and free from centers, the cranks being connected at an angle of 90 degrees. It is especially designed for derrick use and also finds widespread application for pile driving and dock building. In pile driving a vast amount of time is saved by hauling the pile in position by means of one drum while the hammer is handled by the other drum.

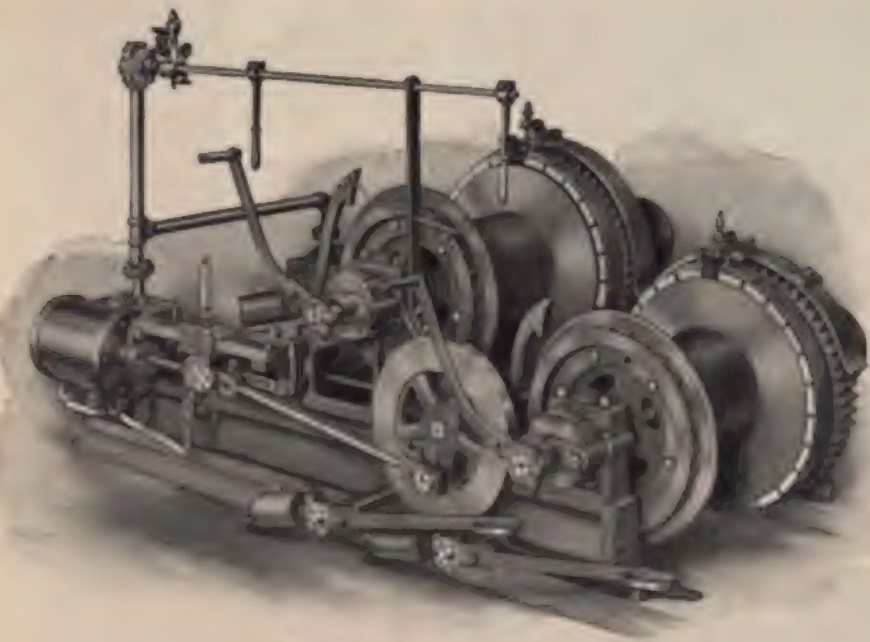
An important feature of this engine is that both drums are operated by one man and under complete control, the levers for working the drums, brakes and throttle valves being so located that he can easily operate both drums without changing his position. This is an important point as in many types of hoisting engines the operator is obliged to change his position in order to operate various valves simultaneously, which is very apt to cause confusion and the possible working of the wrong lever at the wrong time.

The cylinder cocks of this engine are connected by means of arms and can be simultaneously opened or closed by one movement



LIDGERWOOD DOUBLE DRUM ENGINE.

without boiler and with No. 4 boom swinging gear.



LIDGERWOOD DOUBLE DRUM ENGINE WITHOUT BOILER.

of a small upright lever within easy reach of the engineer.

On pages 624 and 625 are shown the Lidgerwood double drum engine equipped with what is known as the Number 4 boom-swinging gear. While the latter is the most expensive type of apparatus of its kind on the market, it is claimed by its manufacturers to be the only successful one in operation today. Its chief features are simplicity, accessibility, and ease of adjustment. In addition, it is possible to place the gear on any double drum derrick engine with unskilled labor.

The gear consists of a drum shaft with two gear wheels and two drums, and a friction shaft and two frictions and pinions mounted on side stands and tied together by two flat steel braces, secured to the bottom of the side stands and countersunk, making an independent apparatus mounted on an extension of the engine skids and fastened to the front ends of the engine bed-plate by bolts with jam nuts. The skids are extra heavy.

The friction shaft is driven by a pinion adjoining the winch-head on the forward drum shaft, meshing with an idler gear driving a gear wheel keyed fast to the outer end of the friction shaft.

There are two cone frictions on the friction shaft; the male parts carrying the friction woods, mounted on the shaft with a feather key, and the female parts cast with a pinion mounted loosely on the shaft. The pinion of one drives a gear directly on the drum shaft, turning the drums in one direction, while the pinion of the other drives an idler pinion which in turn drives the other gear on the drum shaft, turning the drums in the other direction. The drums are smooth or spirally grooved if so ordered. The ropes wind over on one drum and under on the other.

When the one friction is thrown into contact the rope is wound up on one drum and unwound on the other. When the other friction is thrown in contact the reverse operation occurs. As the ropes are attached to the bull-wheel of the derrick it is thus swung in either direction.

The frictions are applied by means of nuts, traveling on composition sleeves having screw threads mounted on the friction shaft, and attached by suitable connections to an auxiliary shaft carrying the vertical operating lever. When this lever is in a central (or vertical) position neither friction is engaged. When it is moved forward it causes one nut to travel on its screw and pushes one friction cone into

engagement. At the same time, the other nut releases the other friction cone. When the lever is moved back the reverse takes place. Thus one lever controls the swinging of the boom in a simple and effective manner.

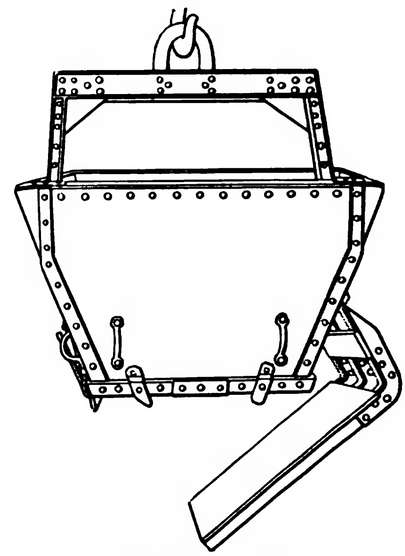
One of the swinging drums is keyed fast to the shaft, and the other is loose, but is prevented from turning by a collar keyed to the shaft equipped with lugs fitting into corresponding recesses in the drum. When the collar is loosened and moved back the drum may be revolved far enough to take up the slack due to the stretching of the rope and the collar then moved back into place and secured.

As the drums are located outside the bearings, the ropes lead fair to the bull-wheel, and the drums are not in the way of the hoisting and boom lines.

Cyclopean Bottom Dumping Buckets.

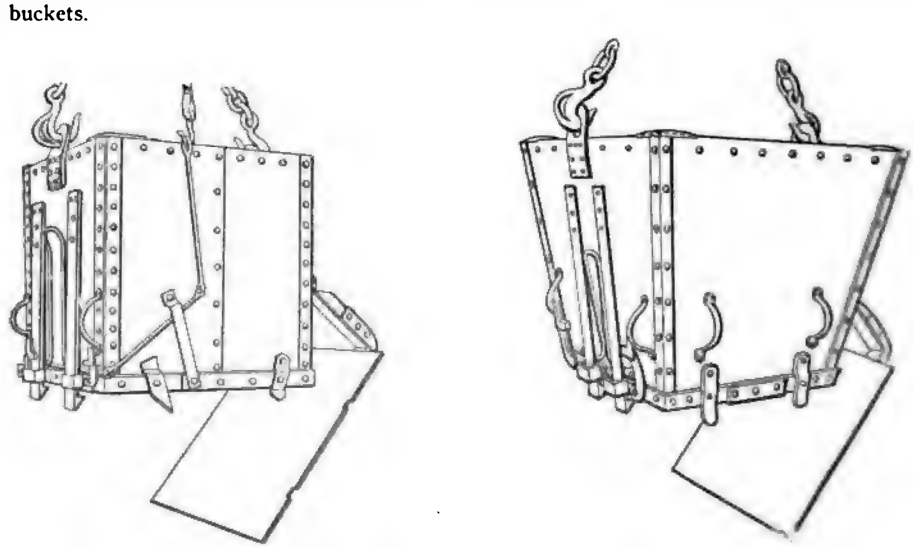
THE advantages gained by "depositing" instead of dumping a bucket of concrete are many and great. For example, the initial set of the concrete already placed need not be disturbed, the concrete may be placed in a mass right on the spot, there is no splashing and rattling of the concrete and the bucket being easily handled can be dumped in the exact spot without damage to forms or framework. Recognizing the extreme importance of these points The Cyclopean Company have been manufacturing and improving under the James J. Harold patents their bottom dumping buckets.

These buckets have a slight flare towards the top and as the inside is absolutely smooth (all rivets being flat-headed and counterset) the bucket dumps clear and clean instantly. As the bottom is attached—by a long arm hinge—well up the side of the bucket, it may



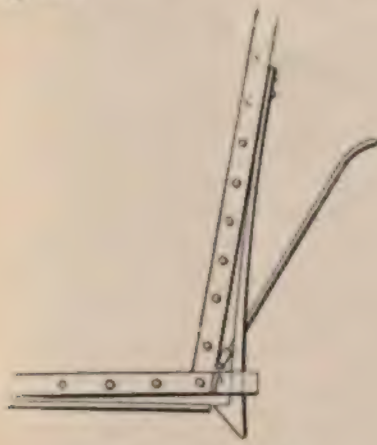
Bucket with Solid Bail.

be said to "drop" out instead of gradually swinging aside. The effect of this is to deposit the concrete in bulk instead of letting it slide out as the bottom swings aside. The bottom is released by pulling a small lever, which opens the latch springs while the bucket



Showing Tripping and Lifting Arrangements.

closes and locks itself automatically as it is returned to the mixer. The saving in time and trouble from this automatic action is readily seen.



Showing Dumping Device.

Detail of dumping device is shown in cut—and the many advantages of this arrangement over the sliding bottom type are obvious. Nor is it necessary to use a hammer to open the latches as is the common method with ordinary dumping buckets. There are no chains or levers inside of the bucket and no concrete returns to the mixer undumped or sticks and sets to be broken off later with a pick. All chain bails are supplied, the special hook shown in the cuts making it safer for the man handling it as well as saving time in operation.

The special deep sea buckets are a great aid to the contractors and engineers having subaqueous work in hand, as they can be operated from the surface by means of a tug line without the aid of a diver.

Cyclopean bottom dumping buckets are made in many styles beside the ones shown and in sizes up to 3½ cubic yards capacity. A complete catalogue will be furnished upon request to The Cyclopean Company, No. 34 Franklin street, Greenpoint, Brooklyn, New York.

Special 1-Ton Electric Traveling Cranes.

THE three special 1-ton three-motor electric traveling cranes illustrated in figures 1 and 2 were designed and built by Pawling & Harnischfeger, Milwaukee, to serve the pits for annealing cast iron chilled car wheels in the new wheel foundry of the Chicago, Mil-

Fig 1—WHEEL FOUNDRY CRANES AND PITS.

waukee & St. Paul Ry., and to meet with the requirements of the service as conditions were presented.

The crane bridges are of channel construction, riveted together with the truck axle boxes supported in channels that form the these being chilled wheels, ground true. The ends of bridges.

There are cross-shafts on both sides of the bridge to which the truck wheels are keyed, bridge drive motors fastened to sides of bridges have connection to cross-shafts through two reductions of gearing. The bridge foot brakes each consist of two hinged shoes enclosing a band wheel that is keyed to intermediate shaft of bridge drive. These shoes are operated by a toggle connection to the foot levers at bottom of cages by reach pipes. The bridges are thus under immediate control of operator without the necessity of reversing the motor to stop the drifting of bridge when it is desired to stop at a certain place.

Suspended from and in the center of bridge are the operators' cages that extend to about a foot from top of pits, thus permitting the operator to travel with the work. A switchboard is fastened to the cage, from which the current is distributed to the motors.

Two one thousand pound capacity fixed hoists are fastened to the underside of each bridge, so located that the hoisting ropes and bottom blocks hang directly over the center line of pits, each crane serving two rows of pits. The hoists are high speed, direct lift and independent of each other. Steel castings bolted to bridge channels support one end of the drum shafts and also make a base for fastening the gear cases that contain all the hoist gearing and mechanical brakes, thus providing a rigid and self-contained construction. To one side of gear cases are fastened the hoisting motors, the armature shafts extending through to receive the electric motor brakes that are attached to opposite side of gear cases.

WHEEL CRANE SHOWING PLATFORM AND TONGS.

Machine cut spur gearing is used throughout, and all bearings are bronze bushed.

As the operator stands in the cage, the three controllers are within easy reach, and, when operating the tongs in the pits, he is able to guide them into the cored hole of the wheel to be lifted.

The foundry is equipped for turning out 600 car wheels per day. Many special features have been introduced, including the cranes above described, to facilitate the molding and handling of this output. The annealing of the wheels is done in shells made of boiler plate lined with fire brick, and provided with double covers over the tops. There are some 150 of these ovens, each one holding 16 wheels. As shown in the illustration, the ovens are placed in a large pit with concrete walls and are surrounded with sand, thus preventing the radiation of the head and allowing the wheels to cool slowly.

The wheels are taken from the molds while at red heat and transported on special cars to the cranes for placing in the ovens, the risers being knocked off as the wheels are in transit.

It takes four days to properly anneal and cool the wheels, which accounts for the large number of ovens required.

Draining the Everglades.

Big as is the tillable portion of the United States, large tracts are still being added, either by drainage or irrigation. While in the far West the artificial watering of desert lands is costing many millions, there is a stupendous work under contemplation in the South of an opposite nature. It is proposed to drain the Everglades of Florida.

Governor Broward, in writing of the great scheme, which is now a leading issue before the people of that State, enumerates the main features of the plan. There are 7,500,000 acres of swamp land to be freed of water. In the midst of this dreary waste lies Lake Okeechobee. It is proposed to cut canals and drain off part of the waters of this lake, so as to reduce the surface four feet to prevent the overflowing, which now floods 1,000,000 acres of the surrounding country.

The work calls for 550 miles of canals ten feet deep and varying in width from 50 to 120 feet. From these main arteries will be cut smaller ditches [illegible]h must be made by the purchasers of the property. Altogether, the cost will be $1,000,000.

This is a large sum for a commonwealth no richer than Florida, but that fact makes the enterprise all the more commendable.

Rubber Substitutes.

IT IS a well known fact that the production of rubber does not keep up with its consumption. The constantly increasing demand for it cannot be met, and the price of it goes steadily up, though larger quantities than ever before are now brought into commerce from the Congo districts.

This steadily increasing demand for rubber has also induced the chemist to seek for substances possessing properties resembling those of rubber, but up to the present time none has been found, which equals it as regards elasticity, tenacity, chemical indifference, and insulating power for electricity. However, compounds possessing to a great extent the above mentioned properties are now successfully produced, and may be substituted in many cases for rubber. By the invention of such masses great service has been rendered, especially to the electrical industry, because many of them possess the highly-important property of rubber, namely, the power of insulation.

The rubber substitutes may be divided into two groups: Masses containing rubber, but only in subordinate quantity, while the main mass consists of other less valuable substances; and masses which contain no rubber whatever, but are prepared from various substances, and yield a product which may for many purposes replace rubber, thus representing a rubber substitute in the actual sense of the word. According to a certain method a material which may be utilized as a substitute for rubber is prepared as follows: Waste rubber is dissolved with the application of heat in drying oils. The resulting solution is strongly heated and while constantly stirring, a current of air is conducted through it, till a cooled sample shows the proper consistency. The actual rubber substitutes, i. e., masses containing no rubber whatever are prepared by a peculiar treatment of oils. By treatment with chemicals the oils, in all cases, undergo such far-reaching chemical changes that they cannot be called changed oils, but must be designated as products formed from the oils. The general term oil-rubber has been applied to these products.

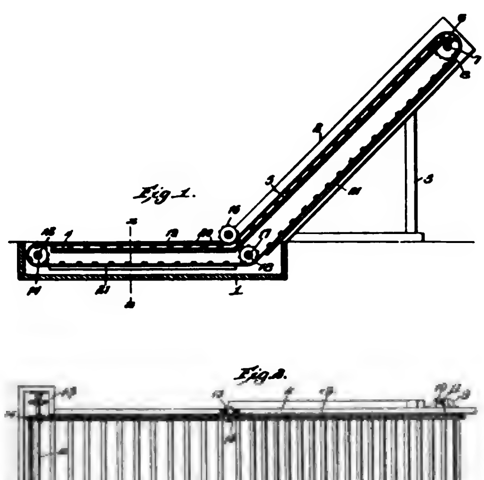
New Inventions.

The following inventions have been specially reported for Browning's Magazine by C. LeRoy Parker, Solicitor of Patents, 639 F. St., N. W., Washington, D. C.:

ELEVATORS.

THE accompanying illustration shows an elevator designed for carrying boxes and small packages for which a patent was recently issued to Alfred Menard, of Salix, Iowa.

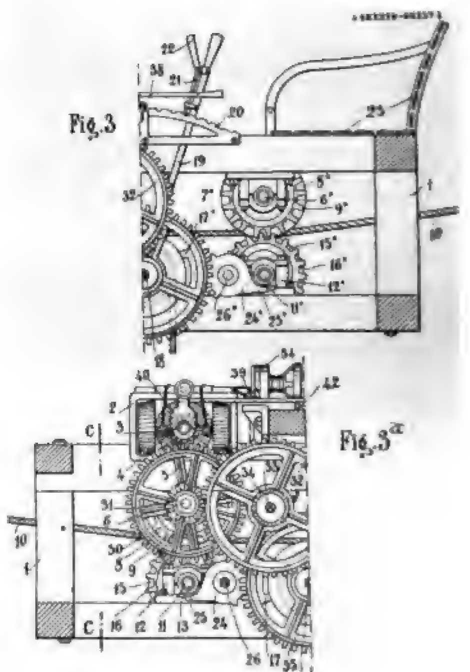
Material to be elevated is piled upon the platform 4 and that portion of the apron disposed thereabove, and by rotating the shaft 12 the apron can be caused to move upward upon the platform 5, and the slats will therefore engage material and convey it upward to the downwardly curved flange 6, where it will be discharged into a vehicle or receptacle located thereunder. As the platforms are contacted by the slats, it will be understood that



the apron is relieved of all strain except that exerted by the longitudinal pull thereon. Moreover, the cleats 21 support that portion of the apron below the platforms, and therefore the apron is held at all times in proper position and cannot become displaced from the sprockets. By disposing the casing 1 below the surface of the ground a wagon containing material to be elevated can be driven into position upon the platform 4 without injuring it.

SUSPENSION CABLEWAY SYSTEMS.

IT is customary in suspension cableway systems to have an endless supporting cable moving by means of a motor which generally is placed at one end of the track along which the cable is supported by means of pulleys. The cable is moved in the other direction by means of a return station placed at the other end of the track, and the cars carrying the load are secured to the cable, so as to move on the track and with the cable.



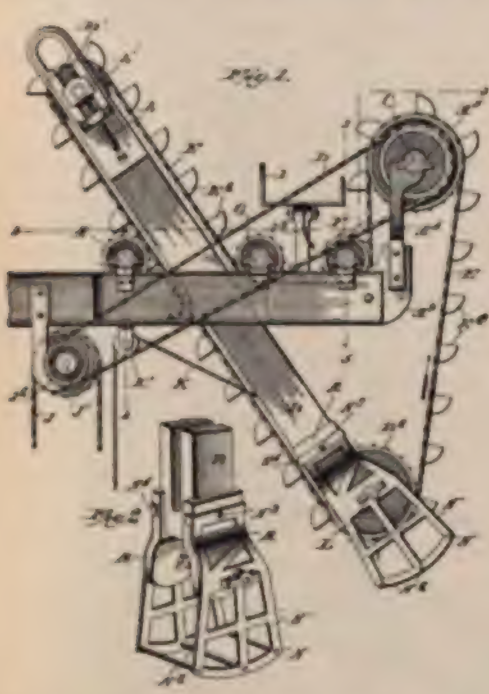
In this invention recently patented by Hermenegildo Bozzalla, of Torino, Italy, the car moves on two fixed metallic cables which merely serve the purpose of supporting the car, and a motor is mounted on the car and furnishes the necessary energy for moving the car with its load along the track.

The invention is defined in the patent as consisting of a suspension cableway system, comprising a pair of fixed cables, a car having traveling connection with the cables at both ends, and means for clamping the cables to the traveling connections of the car; said means being constructed to break the clamping connection at one end of the car when

the other end of the car is clamped to the cables.

DREDGING MACHINE.

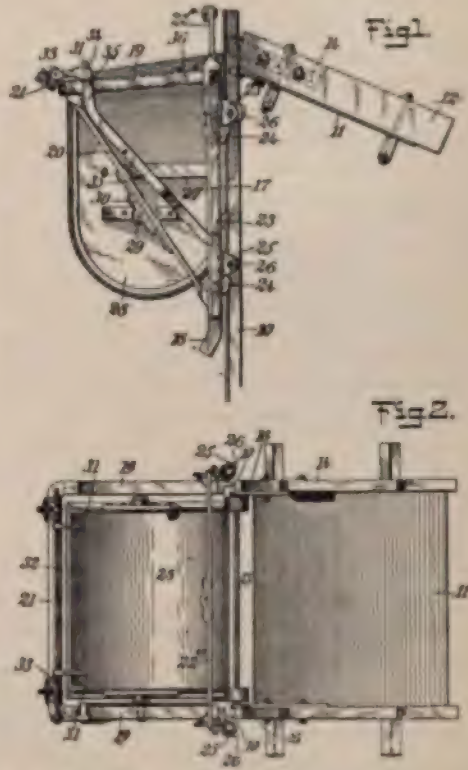
CHARLES V. FOREMAN, of Thurmont, Maryland, has recently patented a dredging machine comprising a novel arrangement of buckets and bucket supports which is claimed to be highly advantageous. It will be noticed that the carrier chain passes over the sprocket wheel C^2, thence down and under the sprocket wheels F and G, and on its downward movement the buckets of the carrier discharge into a rocking chute I, which extends transversely above the beam A in a



line between the sprocket wheels F and G and is pivoted at I' to a bracket I^2, so it may be rocked to discharge to either side, and suitable stops are provided. There may be lugs i and i' on opposite sides of the bracket I^2 for limiting the movements of the chute I in either direction. It will be noticed that the location of the sprocket wheels F and G relatively to the bucket slide and the rocking chute is such as to permit the discharge of the material from the buckets E^2 into the chute I, so it may be delivered thereby into scows or other receptacles arranged along with side of the beam A of the dredger.

HOIST.

THE object of this invention is primarily to adapt a hoist to handling mortar, lime, cement, brick, and other material required to be carried in a hopper or bucket. In attaining this end there is provided a carriage which is adapted to move along a vertical track and which pivotally supports a bucket. Co-acting with the bucket is a peculiar latch and trip, by means of which the bucket is held during the ascent and automatically released when the top of the track is reached, the bucket being pivoted off center, so that as



the bucket is released the bucket automatically tilts and dumps its load.

In the operation of the invention the parts are assembled as shown in the drawings, and the carriage with the loaded bucket is raised along the track 10. The parts are so arranged that when the bucket reaches a point level with the chute 11, so that the load of the bucket may be properly dumped in the chute, the offset portion 35^d of the trip will run into engagement with the adjacent trip roller 16. This will throw the trip outward and raise the

bend 35ª, thus rocking the shaft 32 and disengaging the dogs 31. The bucket then tilts by gravity forward and empties its load on the chute 11. When the bucket has been emptied, the carriage should be allowed to descend, the rollers 16 then engaging the bucket and throwing it back to the upright position shown. As this operation takes place the front edge of the bucket strikes the dogs 31 and passes under them, allowing the dogs to fall and retaining the bucket in place until the trip is again actuated to release the dogs.

The hoist is the invention of S. T. Wallace of Los Angeles, Cal.

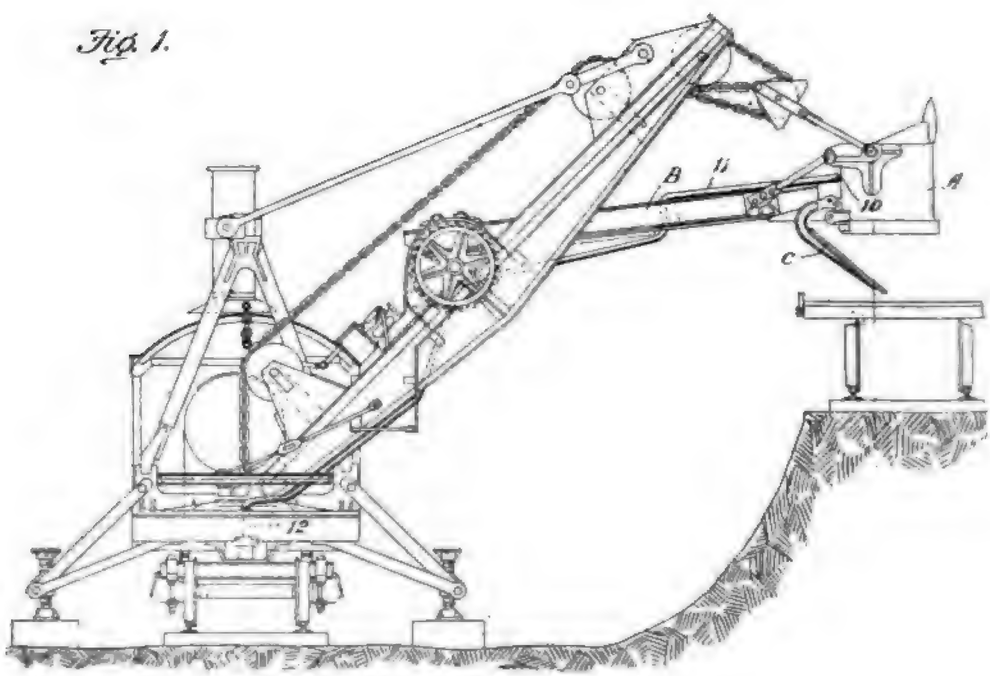
EXCAVATOR DIPPER.

THIS invention relates to excavating apparatus of that general type in which a dipper or shovel is employed to excavate the dirt or other material, and especially to devices of that class in which the bottom of the dipper is movable to open position to allow the discharge of the contents by gravity. In operating these dippers especially where soft clay or similar material is being excavated, there is considerable difficulty in effecting the discharge of the entire contents of the dipper at each operation, and in ordinary practice a percentage of the material will remain within the dipper to be carried back for the next excavating movement, with the result of increasing the work and materially reducing the capacity of the apparatus.

The principal object of the present invention is to provide for the discharge of all or practically all of the contents of the dipper each time the bottom of the dipper is moved to open position.

The excavating apparatus includes a dipper A, a dipper handle B, caried by and operated in the usual manner, the dipper being provided with a pivoted bottom member C, which is opened for the purpose of discharging the load. In carrying out the invention the rear wall of the dipper is provided with a threaded opening in which is screwed a nipple 10, and this nipple is connected by a tube 11 to a fluid supply pipe 12, placed adjacent to the turn table of the machine, the tube 11 being formed wholly or partly of flexible material, so that it may readily follow the movements of the dipper handle and boom and always remain connected to the source of supply. The source of supply is preferably a water tank; but under some circumstances compressed air may be utilized. This fluid, whatever its nature, is forced through the tube 11 and the nipple 10 to the interior of the dipper and there acts to assist in dislodging the load. In order to more effectually distribute the current of fluid.

Fig. 1.



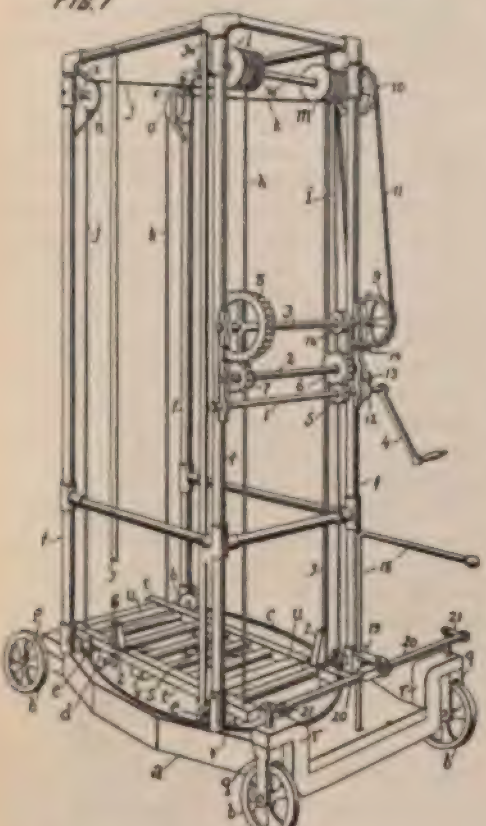
the inner end of the threaded nipple receiving opening is also arranged to receive of openings 16, so that the fluid will be directed outwardly and downwardly, the object being of course to dislodge any material that may tend to cling to the wall of the dipper.

W. H. Bates, of Culebra, Panama, is the inventor.

PORTABLE ELEVATORS.

THE invention shown in the accompanying illustration forms the subject of a patent recently issued to T. J. McCarthy, of San Francisco, Cal. Its construction and operation is obvious from the illustration. It is primarily intended for handling heavy barrels and other packages in store houses.

FIG. 1



Electricity Presents Problems.

The rapid progress that is being made with electricity as a motive power, and the belief by many that it will before long supersede steam as a motive power on nearly all American railroads, has caused a number of vexatious problems to present themselves. Among the perplexing questions which the advocates of electricity as a railway motive power have been unable to solve are the following:

Owing to the fact that the railroads of the United States were constructed under a law of congress which defines them as "roads operated by steam," will the steam roads forfeit their charters by adopting electrical propulsion? What will be the status of a road operated in part by electricity and partly by steam as to rates, operating requirements, wages of operatives, etc.? What will be the effect on the existing steam roads of the lower rates offered by the trolley roads, and, conversely, what will be the effect on the construction and earnings of electric roads produced by rate reductions of the great steam lines? Will it be practicable to operate freight yards with either overhead trolley lines or the deadly third rails?

Greatness of U. S. Steel.

The United States Steel Corporation owns as much land as is contained in the three States of Massachusetts, Vermont and Rhode Island. It employs 180,000 workmen—more than the combined armies of Meade and Lee at Gettysburg. More than a million of the American people—as many as the population of Nebraska or Connecticut—depend upon it for a livelihood. Last year it paid out in wages $128,000,000—more than the United States pays for its army and for its navy. "Our workmen have a first mortgage on United States Steel," said Charles M. Schwab. It owns and operates a railroad trackage that would reach from New York to Galveston, or from Paris to Constantinople. It possesses 30,000 cars, and 700 locomotives.

The Skyscraper Query.

Notwithstanding the multiplicity of high buildings in New York the prospect of another still higher impresses the crowd. Of all signs displayed down town at the present time the one that attracts most attention is the notice on the site of the Singer building, which states that the new structure will contain forty-one stories, and will be 612 feet high. Passersby stop in bunches to read that sign. Their comments indicate many emotions, but invariably they wind up their remarks with the query:

"I wonder how long it will be before they will build a bigger one?"—New York Press.

Foreign Industrial News.

A $75,000,000 electric trolley system, with double tracks between New York and Pittsburg, is a project of Joseph Ramsey, jr., and associates. Their ultimate aim is to extend to Chicago.

The American motor-car manufacturer is evidently going to invade Great Britain with a cheap car, states the London Financial Times. At the last Crystal Palace show the four-cylinder Ford car for $500 was much talked of. Now the Pope Manufacturing Co. is searching for a West End showroom.

T. Roberts, chief mechanical engineer of the South Australian government, has been appointed, subject to the ratification of the various Australian governments, consulting mining engineer for the whole of Australia, with an office in London. The nomination comes from the Australian commissioner of railways.

Valuable Liberian timber is available for the American markets, reports Consul-General Lyon, of Monrovia. The woods comprise red and white mahogany, red and white whistmore, red and white oak, cedar, cherry, corkwood, brimstone, and mulberry. Mr. Lyon gives the name of a business man (which is on file at Bureau of Manufacturers) who desires to ship this timber direct to the United States.

Heat From Friction.

The Stove and Furnace May Be Entirely Dispensed With—After Twenty Years of Work.

There is an evident return to the first principles in the invention which has lately been devised by Charles S. Baker, a colored resident of St. Joseph, Mo., who has worked out an apparatus for obtaining heat from the friction of two pieces of wood. He has been working on the idea for 20 years and has only recently gotten the thing in such shape as to submit it to the inspection of persons interested. He has constructed a heating apparatus on the lines indicated and has demonstrated that this is capable of heating quite a large building to a very comfortable degree. This machine was installed in the basement of the First National Bank of that city, and since that time thousands of persons have witnessed its operation.

Baker's invention consists of a steel tube three feet long, surrounded by a water chamber, and inside of the tube a wooden roller, cut into four triangular sections and arranged about a steel shaft. The wooden roller is five inches in diameter and the inside of the tube in which it runs is six inches in diameter. The water chamber is ten inches in diameter.

A two horsepower motor is used to operate the machine and tests show that a speed of 700 revolutions it will heat water to a temperature of 160 degrees in 55 minutes. At the rate of 700 revolutions steam is produced in five minutes from the time the machine is started, and in the next 45 minutes steam is made at the rate of a pound a minute.

It is Baker's idea that the machine will finally do away with combustion for all purposes, except possibly foundry furnaces and in other cases where great heat is required.

The rights for this country have been bought by a St. Louis company and that apparatus will soon be placed on the market in a commercial way. One of the active spirits of this company is H. H. Kahn, of that city, who said recently: "It is his intention to sell machines for heating not only steam and street railway cars, but house and office buildings." He feels confident that Baker's invention will revolutionize the business, and that his machine can do the work so cheaply as to drive competitors from the field. Its basic principal is declared to be so simple that the wonder is that it was not practically applied long ago.

"The friction principle is its foundation. This is obtained by the revolutions of the wood-encircled iron rod in a tube against a surrounding cushion of air. This tube is surrounded by water supplied in the simplest manner. The friction of the revolving rod heats the air, which, in turn, heats the tube and the heat from the tube itself heats the water."

Strenuous Japanese Merchants.

Some Japanese commercial notes from Consul-General H. B. Miller at Yokohama are of interest. They read:

Sugar merchants of Nagoya are about to form a sugar-refining company with $250,000 to $500,000 gold capital.

The Tokyo Patent Medicine Guild is chartering a company to extend the market of Japanese patent medicines in China, Korea, and the

South Sea Islands. The scheme is supported by the Osaka Guild.

A Japanese paper states that Mr. Morimoto, a wealthy Kobe merchant, is taking steps to open direct trade with Austria with the assistance of the Austro-Hungarian Minister at Tokyo. The scheme is to import iron and steel manufactures and machinery, and twelve leading iron works in Austria have agreed to send a representative to consult with Mr. Morimoto. The Japanese paper adds that in Austria good paper and porcelain are made, besides iron and steel manufactures, but they have little market in the Far East.

Combination in Wrought - Iron Tubes, Not Steel.

Consul F. W. Mahin writes from Nottingham that the announcement of a combination in the British steel-tube trade is now corrected by the statement that the combination is not among steel but wrought-iron tube makers. Its object is said by those concerned to be defensive, not aggressive. The net effect of the combination on prices will be, it is said, to advance them 7 to 8 per cent on some classes of tubes.

Spark Screens Needed.

Consul A. Halstead, of Birmingham, reports a movement in England to secure greater safety to life and property from the flying sparks or cinders of locomotives. He cites the death of a lady whose summer dress was ignited by a flying spark, also losses to farmers and others from fires caused by locomotives. He writes:

Smokestacks of locomotives in Great Britain are not supplied with screens to prevent the emission of sparks and big burning cinders. Such a device is said to be used here, however, for traction engines employed for agricultural purposes. Complaints of burning cinders have been very numerous this year, and it is suggested that the English railway managers should immediately adopt spark arresters, such as are used in the United States. So long, in fact, have they been used in America that the patents upon them have probably expired; but it is just possible that such American devices might be sold to English railways, now that the dangers from sparks, not only to individuals and property, but also to the beautiful turf that lines the banks of most British railways, has been so forcibly shown this dry season. The question is certainly worth investigation.

Oil Fuel for Japanese Steamers.

Consul C. B. Harris, of Nagasaki, referring to his previous report that Nagasaki shipyards had contracted to build for the Toyo Kisen Kaisha (Eastern Steamship Company), of Tokyo, for use on their Hongkong-San Francisco line two sister ships, each of 13,000 tons, gross, now adds that the vessels are to be fitted to use oil for fuel. He is also informed that the steamship company's three vessels, the *America Maru*, *Nippon Maru*, and *Hongkong Maru*, each of 6,000 gross tonage, now plying between the ports named, will be refitted to burn the same fuel.

The Motor Industry in India.

India is rapidly taking a leading place in the exploitation of the motor industry in foreign fields. It is worth the careful attention and thorough investigation of American manufacturers who are seeking to enlarge their markets. The present time is an unusually good one for them to find out what the peculiar and special needs of the country are and what their competitors are doing to capture and hold the increasingly valuable trade. Reliability trials are to be held at Mysore, in southern India, during the Christmas holidays. These will be folowed by a general motor exhibition at Calcutta from January 21 to January 30, at which all the leading European manufacturers will be represented.

The value of the trade is seen from the official statement that the motor cars, motorcycles, and cycles imported during the last fiscal year amounted to approximately $2,000,000, of which one-half was through the port of Bombay, the supply mart of western India. Accessories, which are classified under different headings, add to this total, while fuel and lubricating oils have had largely increased sales since the use of motor cars has become popularized.

One cause of the popularity of the motor in India is the number and the extent of good roads, some of them hundreds of miles in length.

A perfect highway runs from Bombay to Delhi, 900 miles, over which the trials were made in 1904.

Electrical Manufacture of Steel.

Consul Urbain J. Ledoux reports from Prague that Australian papers are discussing the introduction of the Kjellin process in the manufacture of steel by the Poldihütte, at Kladno, Bohemia, in concert with the Oberschlesische Eisenindustrie-Gessellschaft, which process, says the *Prague Tagblatt*, may bring about a complete revolution in the Austrian steel industry. Continuing, the *Prague Tagblatt* says:

That such steps may be leading to vastly important results may easily be realized when it is considered that the Kjellin process yields an excellent steel, said to be fully equal to the best crucible steel, while the cost of production is considerably lower than with the mode of production so far in use. The Kjellin product, however, apart from its lower cost, is further praised for its ductility, density, homogeneousness, softness, the possibility of obtaining high degrees of carboniferous quality, and, finally, for its excellent magnetic properties. If these surmises—as appears highly probable—should be proved by facts, all undertakings which have at their disposition the primary requisite for the adaptation of the electric process, viz, cheap electric power by means of sufficiently strong water power, will secure a great advantage over other works. Chief Engineer V. Engelhardt, in his work on the Kjellin process, states that it can compete with the Siemens-Martin method, where the kilowatt hour can be put down at about a half cent.

Ottawa a Manufacturing Center.

Consul-General J. G. Foster writes that Ottawa has achieved considerable success as a manufacturing center and is destined to develop materially in this particular in the future. Within a radius of 40 miles there are a number of water powers capable of furnishing, at a low cost, an aggregate of 400,000 horsepower. The mica mines in the vicinity of Ottawa furnish an excellent quality of amber mica. Indeed, it is the chief source of supply for the principal manufacturers of electrical machinery in the United States. Among the industries established at Ottawa and across the river, in the city of Hull, are two large paper mills, a match factory, four lumber mills, with an annual capacity of 200,000,000 feet, the largest sash and door factory in the Dominion, a tent and army supply factory, and a gas buoy and marine signal factory. There are 225 different industries in the city, representing $15,000,000 of invested capital, and employing 10,000 hands, with a total annual wage list of $3,000,000.

The total imports for consumption into Ottawa from the United States during 1905 amounted to $1,803,984, of which $1,045,804 were dutiable, and $758,984 free goods. The exports to the United States for the same period amounted to $2,674,925.

Bridges Planned in Vancouver.

Serious Proposition to Connect Island with the Mainland.

Consul A. G. Smith, of Victoria, writes that the engineers and other deeply interested parties are planning not only new railroads in British Columbia, but are projecting engineering schemes by which, if carried out, they will connect the island of Vancouver with the mainland.

The Canadian Pacific (owners of the Esquimault and Nanaimo Railway in Vancouver Island) are preparing to extend the line beyond the 83 miles between Victoria and Wellington to points north and west. One extension of 50 miles is to run from Wellington to the Comox coal mines. Another 50 miles is to connect Nanaimo with Albeni on the west coast.

What the people of Victoria and Vancouver Island most desire, and are persistently endeavoring to bring about, is the extension of the island railroad to Cape Scott, the extreme north of the island, and the bridging of Seymour Narrows by a government railroad toll bridge. Such a bridge, open to all roads, would bring the unbroken trains of transcontinental railroads (whether Grand Trunk Pacific, Canadian Northern, or Canadian Pacific) direct to Vancouver Island, with Victoria as the natural terminus. With this in view the board of trade and citizens of Victoria have presented strong memorials to the Dominion authorities asking the construction by the Government of a railroad bridge at Seymour Narrows, connecting Vancouver Island with the mainland of British Columbia. Plans have been prepared for the construction of such a bridge. The scheme proposes a series of bridges from island to isla longest span from Valdez Is

would be nearly 1,000 feet in length, but as the Quebec bridge across the St. Lawrence has a span of 1,840 feet the one contemplated here could be erected without danger, once the pier is built on rock in center of the Narrows. Competent engineers say this is entirely feasible. It is estimated that the cost of this bridge, or series of bridges, would be from $14,000,000 to $18,000,000 to be paid for by Dominion funds.

Wireless Telegraph and Geography

TELEGRAPHY was never used so much as it is today to ascertain the longitude of places in the lesser known parts of the world. A few months ago, for example, an expedition started inland from the port of Lagos, West Africa, following the telegraph line to the far interior and also lines branching off from the main route. The longitude of Lagos being known, the party was able to fix the longitude of other places by method of comparing the time of the two places by telegraph. During this journey of 2,000 miles, the longitudes of fifteen important points in the interior were thus fixed.

It is easy to find the latitude of a place, but astronomically to determine its longitude is a more complicated and difficult matter. The rapid extension of telegraph lines, so that the time at one place may be compared with that at another, is therefore facilitating more accurate mapping.

But as soon as wireless telegraphy is perfected there will be no need of telegraph wires for comparing the time of any two places. A number of men are now trying to place the determination of longitudes by wireless telegraphy on a practical basis. The effort will succeed some day, and then wireless telegraphy will give a great impetus to the making of better maps.—Exchange.

Costa Rican City Contracts for Sewerage.

Consul J. C. Caldwell reports from San Jose that the contract for the sewer system at Cartago, Costa Rica, has been awarded to Felipe J. Alvarado, a merchant of San Jose and Limon, and Nicolas Chavarria, a Government engineer. The latter has gone to Europe and the United States to purchase material.

The contr ... colones, equal to $ ... proposed to erect a purification plant of double capacity instead of two smaller plants, as called for. The contractors have been in communication with the authorities of Charlotte, N. C., and have decided to adopt a system of purification similar to one in use there. Exemption is to be secured from import duties for all material used in connection with the work.

Japanese Industrial Energy.

Busy Supplying San Francisco with Cement.

Consul-General Henry B. Miller forwards from Yokohama a number of Japanese newspaper reports giving information concerning important industrial movements there as follows:

The cement industry has greatly revived, the demand increasing in home, Manchurian, and Korean markets, while large orders have been received from San Francisco. The Osaka Cement Company, though working night and day, is unable to keep pace with the demand. The present capacity of the works is 13,000 barrels a month, and it is proposed to increase the plant to obtain an output of at least 250,000 barrels per annum. The necessary machinery has been ordered, the extension to be completed by the end of October.

Extent of the Canal Job.

Estimates of Excavation to be Done and Structural Material Required.

WASHINGTON, Nov. 2.—Some idea of the vastness of the Panama Canal project is conveyed in a circular issued by the commission today for the information of prospective bidders for constructing the canal. The summary shows that the estimated excavation and structural material in these sections are approximately as follows:

Colon section, 9,445,000 cubic yards; Mindi, 11,000,000 yards; Gatun locks, excavation, 3,660,000 yards; concrete, 1,302,080 yards; steel gates, 29,230,000 pounds; Gatun dam, earth filled, 21,200,000 yards; Gatun regulating works, excavation, 1,580,000 yards; concrete, 189,000 yards; sluices, 5,000,000 pounds; lake section, excavation, 24,000,000 yards; Culebra, excavation, 39,000,000 yards; Pedro Miguel, excavation, 6,835,000 yards; Pedro Miguel lock,

excavation, 1,170,000 yards; embankment, 1,100,000 yards; back fill, 390,000 yards; concrete, 513,612 yards; cast iron, 732,000 pounds; steel gates, 19,500,000 pounds; Lake Sosa section, excavation, 1,680,000 yards; Sosa locks, excavation, 1,430,000 yards; back fill, 950,000 yards; concrete, 992,800 yards; cut stone, 600,000 yards; brick, 14,000 yards; cast iron, 1,281,000 pounds; steel gates, 37,180,000 pounds; La Boca Dam, 6,300,000 yards; Corozal-Sosa Dam, 5,397,000 yards; Panama Bay, excavation, 8,528,000 yards.

Consular Reports.

By HAROLD J. PACK.

THE United States Consuls in the various parts of the world submit reports from time to time on such subjects as it is thought will be of interest to the home government or the people of the United States. These reports are based on direct personal investigation and examination, or are taken from periodicals and magazines and supplemented by personal investigation and examination.

These reports are sent direct to the State Department, which department has entire charge of the Consular Service. They are then turned over to the Bureau of Trade Relations, where they are carefully examined for the purpose of eliminating all remarks of a political, censuring or otherwise objectionable character. The reports are then sent to the Bureau of Manufactures, Division of Consular Reports, where they receive such careful editing as can be given them in the short time between their arrival and their publication. This last editing is for the purpose of eliminating all useless matter, putting in only that which will be of interest to the public. The Division of Consular Reports often supplements the reports that come in with information from the office files on the same subject.

Consuls are urged to be on the alert and observe and report everything of a political, economic or commercial character which might be of use or interest to the government officials at Washington or to the people of the United States, and a constant stream of reports containing useful information is coming in all the time from all parts of the world. In addition to the reports submitted on the initiative of the Consuls, the Division of Consular Reports, through the Bureau of Manufactures, from time to time sends requests to the Consuls, through the State Department, for reports upon special subjects to which its attention has been called by leading merchants, manufacturers, Chamber of Commerce or conventions.

In addition to the above, Congress a little over a year ago, made an appropriation of $30,000.00 to be expended by the Division of Consular Reports in sending expert agents to all parts of the world for the purpose of making special investigations and examinations into our trade relations with the various countries, and to submit reports on conditions as they found them, with suggestions for improvement. They were also to investigate and report on any special industries, if directed. Five men especially equipped for such work were immediately sent out; one to South and Central America, one to Mexico, one to Canada and two to China and Japan. An increased appropriation was made this year, and seven agents are now in the field. One has been sent to England and the Continent to investigate cotton manufactures, and another is in South Africa.

The Bureau of Manufactures is serving a practical purpose in bringing together the business men of the country with their needs and those who can supply them. A Baltimore party wrote the Bureau a few days ago for information as to where he could secure supplies of tripoli and other minerals. The day following a letter reached the Bureau from Missouri asking where tripoli could be sold.

A great steam shovel operation is planned by the Oliver Mining Co., which calls for stripping the overburden from 80 acres of ore at Coleraine, Minn. The average depth of the stripping will be about 80 feet, and it is estimated that 13,000,000 cubic yards must be excavated. At Holman, not far away, the company is planning to undertake almost as much work of the same nature.

The Osborn Engineering Co. has awarded the contracts for a new plant for the American Seeding Machine Co., to be located at Richmond, Ind. The buildings will be of brick and steel construction and will cost about $135,000. A number of Cleveland contractors submitted bids for the work. The contract for the steel work has been awarded to T. H. Brooks & Co., and the general building contract has been let to Louch & Hill, of Richmond, Ind.

Aluminum Silver.

ALUMINUM silver is now quite extensively used for the parts of typewriters most exposed to corrosion. The properties of the alloys are extreme stiffness, together with a white color and sound casting qualities. It has replaced steel forgings or malleable iron castings which were formerly used for the purpose.

The Seven Follies of Science.

The Fixation of Mercury.
The Elixir of Life.
The Squaring of a Circle.
The Duplicating of a Cube.
The Trisection of an Angle.
Perpetual Motion.
The Transmutation of Metals.

Making Sawdust Produce.

The incorporating of a big company in New Orleans, the business of which it will be to manufacture charcoal by a new process, and also to manufacture turpentine, fuel and furniture polish from sawdust, is attracting a great deal of interest in Louisiana, says a special news dispatch. The name of the concern is the New Orleans Charcoal Company, and it has an authorized capital of $250,000. At the head of the enterprise are W. R. Stringfellow, William Danner and F. S. Flower. The experimental plant is now in process of building. The principal business will be the manufacture of charcoal from the saw mill refuse, the other substances being by-products. When the success of the system shall have been demonstrated it will be the business of this parent company to manufacture the machinery for the general trade. Charcoal is manufactured in retort, and all the gases are taken out, so that dejected people would hardly be able to use it to put an end to their troubles. The gases are used for running the plant. Any kind of wood can be used. It is claimed that the charcoal has hardly any dust in it.

The turpentine plant has not yet been established. The turpentine is to be extracted from sawdust, which, after the turpentine, furniture and ligneous acid have been extracted, will be put up in briquettes and sold for fuel. This company is separate from the other, though the same people mostly are interested. It has an authorized capital of $1,000,000. The process of making turpentine out of pine lumber has already been tried, but has not been very successful. This new plan is to make it out of the sawdust, which has heretofore been entirely wasted, and have the sawdust as fuel afterwards. It is also practicable, the promoters say, to make the turpentine directly from pine lumber, and improve the lumber by doing so, as it will not have to be kiln-dried afterwards.

Building Materials in Morocco.

Reports from Tangier state that there is a large and increasing demand in that part of Morocco for cement and building material of all descriptions. The reason of the increase in the importation last year of cement, bricks, tiles, hardware and furniture is to be found in the great stimulus experienced in the building trade.

The right of foreigners to acquire land having been confirmed by the Powers represented at the Algeciras Conference, the demand for building materials of all descriptions, will, it is said, increase considerably. There is sure to be a great demand for tools of all sorts and descriptions, and all the many conveniences required for a modern town will be in demand. Steel and iron girders and iron mongery of all kinds were imported in large quantities during the past year.

ENGINEERING REVIEW.

Locomotives vs. Motor Cars.

"ONE of the problems which must receive due consideration in connection with a change from steam locomotives to electric equipment is that of the cost of maintenance," said Clement F. Street, commercial engineer of the Westinghouse Electric and Manufacturing Company, in reading a paper before the New England Railroad Club, "and this problem has been the subject of more or less discussion in clubs of this nature. At a recent meeting of the New York Railroad Club a comparison was made between the equipment at terminals necessary for handling electric and steam locomotive equipment, in which the impression was given that the former required a greater amount than the latter. An investigation of the subject will hardly bear this out, as one of the heaviest items of expense incident to the maintenance of steam railroads during the past few years has been the extension to and construction of repair shops, and some of our large steam railroads now have several million dollars invested in shops for making repairs to locomotives alone. An investigation of the electric lines will show that no such investment is necessary for the maintenance of this equipment. For instance, at the terminal of the underground system of the Interboro railway in New York we find a repair shop of very small dimensions, containing a very few machine tools, all of light capacity, and giving employment to probably forty or fifty men. In this little shop all of the repairs are made to an equipment of 430 motor cars each equipped with two 200-horsepower motors, or a total equipment representing 172,000 horsepower in 860 motors. This would be equivalent to 215 steam locomotives of 800 horsepower each. It will be found that a steam railroad having in the neighborhood of 200 locomotives to keep in repair has shops covering many times the area of those of the Interboro and containing equipment of tools and machinery much more extensive and giving employment to five or six times as many men; and in addition, several round-houses any one of which represents a greater investment than the entire Interboro shops. This, however, does not begin to represent the total difference between the cost of maintaining steam locomotives and electric equipment.

"The average terminal charge for cinder pits, turntables, inspection, etc., is about $1.50 per locomotive which enters the terminal, while the corresponding cost per motor car is only from 20 to 25 cents. Assuming that three motor cars are equivalent to one locomotive, this gives a charge of 65 cents for motor car equipment against $1.50 for steam locomotives.

"The average cost of maintaining steam locomotives has for some years past, owing to the great increase in the weight of these machines, increased to figures which are somewhat startling. On one of the largest railways of this country, the cost per locomotive per year for 1904 was $3,772; for 1905, $4,165. On another road the cost for 1905 was $3,473 per locomotive. On another, $3,565. These, however, are exceptionally high figures, as on some roads the cost has been as low as $2,200 to $1,500. On thirteen of the largest railways the average cost of 7,227 locomotives for 1904 was $2,212. The average cost per year for maintaining an aggregate of 7,684 motor cars, making an aggregate of 157,059,386 car miles, was only $107 per motor car per year. The average for maintaining the steam plant electric plant and cars, including electric equipment, on these roads, was only $255 per car per year, or about one-eighth of the cost of maintenance per locomotive per year on the thirteen steam roads referred to.

"It is only reasonable to suppose that the cost of maintaining electric motors on roads such as are now being operated by steam locomotives will be much less than the cost of maintaining motor cars on street rails, as the amount of dust and dirt to which they will be subjected will be very much less.

"A comparison of the number of parts subjected to constant wear on steam locomotives and the electric equipment shows that it would

be only reasonable to suppose that the cost of maintenance will be very much less than the latter. The parts of steam locomotives subject to constant wear during service are as follows: 1, cylinders; 2, guides, 3 cross heads; 4, crank pins; 5 links and blocks; 6, valves; 7, valve rods; 8, rocker arms; 9, rocker shaft; 10, pistons; 11, piston rods; 12, piston rod packing; 13, valve rod packing; 14, reverse lever, 15, throttle; 16, throttle packing; 17, truck axle bearing.

"The parts of electric equipment subject to constant wear are motor bearings, brushes, commutators and trolley. With motor cars gears should be added to the list, and with electric locomotives having forced ventilation the ventilating fan and fan-motor should be added. The wear of brushes is a small item, as the tests made with the New Haven locomotive show that one set will run 12,000 or 15,000 miles, which will represent from two to three months' service.

"It might be argued that controller fingers and unit switch fingers should be added to this list, but the wear on these parts is small. Controller fingers with multiple switch control are subjected to only fourteen volts and seldom give out. The multiple unit switch fingers have been subjected to most severe tests and several of them have broken the current to which they are subjected in service one hundred thousand times without being worn out.

"Portions of the electric equipment are, of course, liable to be burned out owing to short-circuit or abuse, but the liability of such failure is not greater, if as great, as that of burning a crown sheet or flues in a steam locomotive boiler owing to low water, and the results are not nearly so disastrous as they are never accompanied by a loss of life and seldom the laying down of the train. If a flue blows out or the crown sheet goes down in a locomotive, it must abandon its train and be hauled home dead, if it has not been derailed, while if a motor is burned out, this motor can be cut out and the car or locomotive can take its train home without difficulty."—*Southwestern Electrician.*

A $75,000,000 electric trolley system, with double tracks between New York and Pittsburg, is a project of Joseph Ramsay, jr., and associates. Their ultimate aim is to extend to Chicago.

Fan Blower Design.

THE velocity with which air escapes into the atmosphere from a reservoir is dependent upon the pressure therein maintained and upon the density of the air. The pressure per unit of area divided by the density per unit of volume gives the head, usually designated as the "head due to the velocity." The velocity produced is that which would result if a body should fall freely through a distance equal to this head. In the case of air, however, an actual homogeneous head never exists, but in its stead we have to deal with an ideal head which can only be determined by dividing the pressure by the density. As the density of air is so much less than that of water it is evident that for a given pressure the head will be far greater in the case of air. But the velocity of discharge is dependent only on the distance fallen, which is represented by the head, whether real or ideal. As a consequence, air under a stated pressure escapes at vastly higher velocity than water under the same conditions.

From the preceding discussion, it is evident that the pressure created by a given fan varies as the square of its speed. That is, doubling the speed increases the pressure fourfold. The volume of air delivered is, however, practically constant per revolution, and therefore is directly proportional to the speed.

The work done by a fan in moving air is represented by the distance through which the total pressure is exerted in a given time. As ordinarily expressed in foot-pounds, the work per second would, therefore, be the product of the velocity of the air in feet per second, the pressure in pounds per square foot, and the effective area in square feet over which the pressure is exerted.

From this it is evident that the work done varies as the cube of the velocity, or as the cube of the revolutions of the fan. That is, eight times the power is required at twice the speed. The reason is evident in the fact that the pressure increases as the square of the velocity, while the velocity itself coincidently increases; hence, the product of these two factors of the power required is indicated by the cube of the velocity.

The actual work which a fan may accomplish must depend not only on its proportions, but upon the conditions of its operation and the resistances which are to be overcome.

Evidently, it is improper to compare fans when operating under such conditions that these resistances cannot be definitely determined. The simplest and most natural condition of operation is that in which the fan is operated without other resistance than that of the case, i. e., with open inlet and outlet. For proper comparison of different fans, the areas through which the air is charged should bear some constant relation to the dimensions of the wheels themselves.

It has been determined experimentally that a peripheral discharge fan, if enclosed in a case, has the ability, if driven at a certain speed, to maintain the pressure corresponding to its tip velocity over an effective area which is usually denominated the "square inches of blast." This area is the limit of its capacity to maintain the given pressure. If it be increased the pressure will be reduced, but if decreased the pressure will remain the same. As fan housings are usually constructed, this area is considerably less than that of either the regular inlet or outlet. It, therefore, becomes necessary, in comparing fans upon this basis, to provide either the inlet or the outlet with a special temporary orifice of the requisite area and the proper shape, and make proper correction for the contracted vein.

According to the B. F. Sturtevant Company. the square inches of blast, or, as it may be termed, the capacity of a cased fan, may be approximately expressed by the empirical formula: $D W \div X =$ capacity area, in which $D =$ diameter of fan wheel, in inches; $W =$ width of fan wheel at circumference, in inches; X = a constant, dependent upon the type of fan and casing. The value of X has been carefully determined for different types of fans; but these values must be applied with great discretion, acquired through experience and a thorough knowledge of all the conditions liable to affect the fan in operation—*The Eng. and Mining Journal.*

Future of Aerial Tramways.

AERIAL Tramways, like many modern conveniences, are not new in discovery, but novel in the possibilities of their application. At least as long ago as 1644 a rope tramway of primitive character was built at Dantzic, Germany, by Adam Wybe, the Dutch engineer, for the purpose of conveying dirt from a high hill called the Bischoffsberg, over the broad town moat to the fortifications beyond. It is not at all improbable that similar devices were used at an even earlier date. At the present time in Norway the peasants employ a wire tramway that accomplishes wonderful things in a small way. They make possible the garnering of their crops from the small patches of land on the mountain sides, by stretching wires from each plot of ground down to the barns below. As they gather the hay and grain they tie it in bundles and let it slide down the wire tramway.

But it was left for the nineteenth century to apply the principle to large industrial and engineering problems; and among the myriad and ever increasing adaptations of wire ropes there is no more important phase than the aerial tramway. The urgent cry in the commercial and industrial world today is for transportation, transportation. The productions of forest and farm, factory and mine are clamoring for exchange. In seasons of great prosperity and activity, like the present, transportation facilities become swamped in spite of our net-work of railways and our great waterways. Aerial tramway systems have not yet been developed to meet the demands of long distance transportation, but there seems to be no limit to their utility and it is not at all improbable that in the near future large volumes of freight will be moved long distances by this means. Already goods of every character are carried over hill and dale, mountain and gorge, for distances up to twenty miles. Such feats were considered impossible ten years ago, and it is entirely probable that ten years hence aerial tramways sixty miles long and more will be succesfully operated.

In forest regions where logging would otherwise be impossible the aerial tramway carries logs over inequalities of surface without the least difficulty. The products of mines are dispatched from, and machinery and supplies are readily transported to places otherwise inaccessible except to the wild goat and the mountain climber.

With the present intense interest in aerial tramways continued, it is not too much to predict that they will come into very common use for carrying freight, even in competition with railways on short connections, on account of the cheapness of installation and easy and inexpensive operation and maintenance. In mountain districts this method would be especially desirable, as it would neutralize the difficulty of grades and be immune against landslides, snowslides and snow blockades.—*The Yellow Strand.*

A Graphical Method of Finding the Average Depth for Excavation.

THE determination of the average cut for certain excavations is often quite difficult where the topography of the surface of the ground is irregular; a few hints in this direction may be very useful.

To handle the subject systematically, and at the same time from the standpoint of the practical man, the problem is illustrated in its various phases. In Fig. 1 let AB represent the grade of the excavation, as, for instance, the bottom of a ditch, a trench for sewer or water pipe, etc., and let CD denote the surface of the ground. If CD is parallel to AB the problem appears in its simplest form. and the height AD or BC is the average depth of the cut.

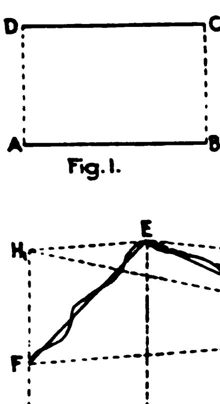


Fig. 1.

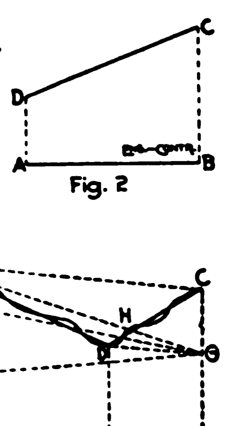


Fig. 2

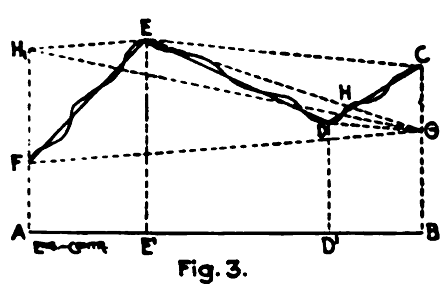


Fig. 3.

In Fig. 2 is shown a case where the grade of the excavation and the surface of the ground are not parallel; the average cut in this case is found by adding AD and CB together and dividing by 2; thus if AD = 11 ft. and CB = 16 ft., add 11 and 16, making 27, and dividing by 2 gives 13½ ft. as the average cut.

The conditions indicated in Fig. 3 are more difficult; the crooked line C D E F indicates the surface of the ground and the lines CD, DE and EF are to be selected ... to average the contour ... and ...

represents an elevation of the average cutting. A method of figuring the average frequently used is as follows: Divide the base line AB into a convenient number of equal parts, and draw ordinates to the upper boundary lines; then scale the length of all the ordinates, add them all together and divide the sum by the number of reading; thus if there are 20 ordinates between A and B and if the total sum of their lengths equals 360, then the average would be 360 ÷ 20 = 18 ft.

It must be borne in mind, however, that in order to obtain correct results the ordinates must be equidistant, and unless they are chosen near together the method is open to serious objection as it favors errors.

That the same end may be obtained graphically will now be shown, reference being had to Fig. 3. Draw line CE, and draw DG parallel to EC, connect E with G, and triangle CEG has an equal area of triangle CED, and if we omit triangle CEH from both, we have triangle CHG = EHD, or with other words, the area CHG has been transposed into the position EHD, eliminating corners C and D; we next proceed to do away with corner E by changing triangle EFG into another triangle having same base FG and the same height. This is done by drawing line FG, and from E draw EH, parallel to FG, then connect HG and triangle HFG has an equal area of triangle FEG. Thus the irregular area of the given section has been converted into the simple form of the trapezoid indicated in Fig. 2, and the average depth is readily found by scaling BG and HA, adding them and dividing by 2.

It is easily seen that this graphic process can be extended indefinitely, and no matter how many sides there may be in the contour, the final result will be a simple trapezoid.—*Engineering—Contracting.*

An important law which will have a far-reaching effect in France on most of the industries is that recently passed in that country relating to the Sunday rest. The new law restricts trading to six days and imposes a rest on Sunday whenever possible.

Gasoline engines were first employed as a motive power for boats the latter part of the '80s. Since then they have gradually increased in popularity, until now boats driven by gasoline engines are to be found in nearly every ...rter of the globe.

Protecting Galvanized Iron.

ON the West Jersey Division of the Pennsylvania R. R. we had a great deal of galvanized iron which in the past has given us considerable trouble. Much of it is used on small station buildings and sheds but the proper way of protecting it in these localities has not been as difficult to determine as the manner of preserving our large and expensive building, covering the Market Street Ferry Slips on the Camden, N. J., side. The conditions to be met with in that locality are particularly severe. There is much dampness all the time and there are frequent fogs which absorb the gases escaping from the adjoining train shed and from the sewers emptying into the Delaware. These gas-laden fogs settie down on the iron as condensation. full of carbonic and sulphuric acids. The average paint won't stand such an exposure very long and we consequently have had a great deal of trouble from rusting until we came across Bessemer paint which seems to fill the bill to perfection in connection with the Galvanic Primer, about which I shall give further details later on.

In the country we do not have gases and frequent fogs to contend with and our Standard Paint would have answered the purpose nicely if only we had gotten it to adhere properly everywhere. Of course, we did clean off the galvanized iron before painting but did not wait for it to become rusty. I am aware of the maxim laid down by many leading painters that galvanized iron should never be painted until it has become weather worn, but for various reasons we did not follow it. In fact, I could never get myself to believe in this theory because it looked so absurd to go to a lot of expense in having the iron galvanized and to hope that the weather would destroy what you have paid for. To make up for this heresy, I have tried a whole lot of other ways and washes recommended to me by various experts and by books on the subject. I have used vinegar, sulphuric acid, ammonia, muriatic acid and even a mixture of acids and chemical salts recommended by one of the paint journals. The results which I got with these nostrums were generally fair but not uniform. In other words, wherever I had used them there was not as much peeling as before but no matter what I used and how carefully I used it I never was able to stop the peeling *altogether.*

And then finally I made up my mind to do what I should have started with. I concluded that after all theories had failed me I might just as well study up the facts and find out why paint should have such a tendency to pull away from galvanized iron so that after knowing the reason for it, I might be better able to intelligently devise a remedy.

The first thing I did was to find out all I could about galvanized iron and it may interest you to hear that after reading a great deal about the discovery and development of the art of dissolving and depositing metals by the galvanic process I ultimately found that this process had nothing whatever to do with the manufacture of galvanized iron. Our manufacturers all make galvanized iron in about the same manner as they make roofing tin. The only difference is that instead of taking the iron and steel plate and dipping it into molten tin they immerse it into molten zinc. Just then I came across something that at once arrested my attention. I found that in order to protect the molten zinc from contact with the air, the manufacturers kept it covered with strong ammonia water. Naturally, when you pull the zinc covered plate out of this bath some of the ammonia will stick to the coating and you all know what strong ammonia will do to paint. Right on top of this I found another bad thing for paint and that was a non-drying oil. It seems that after the zinc plate has left the bath, it is immediately hung into a tank with hot non-drying oil with the object of giving any excess of zinc a chance to drain off before it has had time to congeal. The plate, which by this time has had little particles of strong ammonia and non-drying oil sprinkled all over it, is now ready for the polishing rollers in which these particles or drops are rolled out all over the zinc coating and are squeezed and polished into it. Now, I knew and no longer wondered why we had so much trouble in getting paint to stick to galvanized iron. The reason is simply that wherever the ammonia predominates, it will be taken up by the oil in the paint which it destroys, causing the paint to crumble and that wherever the non-drying oil is spread in a film over the plate, the paint cannot get a hold therefore in time must form a blister. Right here may be a good occasion to explain a fact known to most observers that galvanized iron is more rustproof than tin in the beginning and nearly always less durable than tin after the rust ha-

start. "There is a reason," as the patent medicine man says, who won't let us enjoy our coffee, and I find this reason to be due to the way in which electricity acts on various metals. Some metals are much more easily attacked by it than others and on this knowledge the galvanic process is really founded. If you take two metal plates and connect them with a supply of electricity so that the current will make a circuit you will find that the plate which possesses the greater amount of resistance will reject the current and will therefore be electro-negative. All of the current will necessarily pass through the other plate which is not strong enough to resist it and which will therefore be electro-positive. One and the same metal may be electro-positive or electro-negative according to its position near to another metal, having a greater or less attraction for electricity; thus if you put a steel plate and zinc plate into a bucket of water and pass an electric current through them, the steel being the stronger will be electro-negative and the zinc having more affinity for electricity, will be electro-positive, which means that the steel will not admit the current and will therefore remain as it is, while the zinc will become the subject of electrolysis and will rapidly change into oxide of zinc, a whitish powder. This knowledge has been used in a very ingenious maner for the protection of boilers using salt water which is apt to rust the boiler plates very badly. To prevent this a few plates of zinc are fastened against the boiler plates and now all one has to do is to replace these zinc plates whenever they have been entirely corroded. I understand that this is done and has been done right along by the English Navy and maybe also by ours. Now, change your experiment by substituting a plate of tin for the one of zinc, but leaving the steel plate in place and as soon as you turn on the current, you will find that the steel has become electro-positive, which means that instead of leaving it indifferent as before the electricity will now corrode it, changing it into oxide of iron, which is nothing less than rust. Now, as we have already seen, the galvanized iron plates as well as tin plates of commerce are nothing else but iron, or rather steel, covered with a veneer of zinc or tin. As long as this veneer remains intact, electricity will not hurt either kind, but let the surface be imperfect or let it become broken and the galvanic action demonstrated by our experiments will take [illegible] electric current will start to oxidize the zinc on the galvanized plates, but will leave the steel intact because, as you may remember, this possesses a stronger resistance than zinc and therefore is electro-magnetic. Theoretically, this is always the case but in practice it may happen that an opposite action develops which all of you have no doubt observed where iron nails have been driven into galvanized iron. You also may have observed that sometimes this starts rusting and sometimes it does not, particularly where the zinc is well protected with paint. This is due to the tendency of the zinc, already mentioned in the former part of my paper, to become coated with a thin film of oxide of zinc, wherever it is exposed to the air. This film which might properly be called zinc rust, is very tenacious and insoluble in water and it will protect the zinc under it and it is often depended upon to protect the entire structure coated with galvanized iron and not painted. I would, however, advise not to depend on this film of oxide of zinc, because it is quite brittle and easily injured and as soon as it is broken the zinc, on account of the change that has taken place in it, will become electro-negative instead of electro-positive as it was before and the consequence will be that the iron will have to assume the electro-positive role just as it does in the case of the tin plate. In the case of the tin plate the break will have the opposite result, allowing the electricity to decompose the iron which is bounded on all sides by the electro-negative tin. The result of this action will be a thin veneer of tin, that looks entirely solid but that will collapse all of a sudden in those parts where the iron has become honeycombed with rust. Of course, this electrolytic action is not as pronounced in practice as it is in the laboratory, because the supply of electricity in the atmosphere is not very great or continuous, except where a feed wire or even a telephone wire furnishes the broken sheet with an independent supply of electricity.

I hope that I have not spent too much time in an endeavor to explain the action of electricity on galvanized iron. The deteriorating effects from galvanic action are no doubt determined largely by the surroundings and I think it is more than likely that they would never be suspected on a freight shed in the country, while in all likelihood they play quite an important part in the case of our ferry shed with a lot of wires, carrying heavy currents passing through and over it. The thing

which should not be lost sight of is that electricity is only one of the agents that cause galvanized iron to become decomposed and that as we have seen, it does not even do so directly, but at the same time does it effectually, by eating up the zinc and laying bare the iron, thus exposing it to the various rust producing agencies.

You may have noticed that I have been using the words iron and steel rather indiscriminately. The fact is that I should always have spoken of steel and not of iron. The term of "galvanized iron" which we all use is quite wrong, if my information is correct. I hold it on very good authority that nowadays very little iron is produced and that if you place an order with the Steel Trust for iron you will invariably get steel. I have been told by a large chemical manufacturing concern which ordered iron plates for some of their buildings, that they insisted that the material must be iron and not steel. When the order was filled they refused to accept the plates, claiming that they were steel. This led to a long dispute because it is rather difficult to draw a line between iron and steel, but as in this case the chemist was a very able man and one who stuck to his guns, the manufacturers had finally to admit that their plates might be called steel but that it would be impossible for their clients to get iron ones anywhere in the United States, unless they paid a fancy price for having them made to order. I am told that the "iron" as we get it now, which really is steel, is better for all practical purposes, being more flexible and tougher than the real iron, but that it must be admitted, that it will rust more easily.

Now, I have given you an ouline of pretty nearly all that has looked to me as if it might be worth mentioning, with the exception perhaps of the very well known fact that unprotected galvanized iron will never prove durable in the neighborhood of train sheds, rolling mills, gas works, glass works, iron foundries and in places where a considerable amount of carbonic and sulphurous gases is discharged into the surrounding air. Zinc is very easily decomposed by all acids, as well as by the salt air of the sea coast and in all such localities it would be just as well to use plain sheet iron and to paint it thoroughly.

However, I am getting away from the subject of my paper, which was to tell how to protect galvanized iron adequately. It won't take me more than a minute to tell you what it has taken me a long time to discover. I have already mentioned that I have found Bessemer paint to be thoroughly proof against the action of the weather and chemical influences and that for this reason I was using it on the Camden terminal.

If any one should wish me to give further details about my experience or if I should not have made myself quite clear in the facts mentioned in my article, I should be glad to discuss them and to supply whatever further knowledge I may be able to place at your disposal—EDWARD HALMACK in *Railway Master Mechanic.*

Stresses in Eye-Bars.

IT will be remembered that during the discussion and correspondence which took place about a year ago with regard to the strength of masonry dams, and the nature of the stresses brought about by the weight of the dam and the pressure of water against it we published the results of some very interesting experiments made by Messrs. J. T. Wilson and W. Gore on a section of a model dam made of rubber. These experiments showed with remarkable clearness the direction and nature of the stresses under the conditions of loading employed. The advantage of rubber for such purposes is, of course, clear, the great flexibility of the material under low stress giving much greater distortion than a more rigid material under similar conditions. The suitability of rubber for experiments of this nature was recently taken advantage of in America by Mr. John D. Van Buren, in order to show the deformation in the head of an eye-bar, similar to those used in bridge work, when subjected to tensile stresses.

In a paper on the subject of eye-bars, by Mr. Theodore Cooper, published in the *Proceedings* of the American Society of Civil Engineers, in January last, the writer points out that our knowledge of the stresses in the heads of eye-bars, when subjected to tensile loads, has been more or less vague, and that assumptions have been made that are not in all cases waranted. The arguments he puts forward are the results of a series of experiments on full-size eye-bars of steel which were tested to their ultimate breaking loads, and the distortions of the head, caused by the increasing stresses, duly noted. These bars were 15 in. wide, and from 1¼ in. to 2 1-16 in.

thick, for pins 12 in. in diameter, and were similar to those intended for the Quebec bridge. Before the tests were carried out the heads of the bars were scribed over the face with a number of fine lines at right angles to the axis of the bar, and others parallel to the axis The distortions, under stress, of these lines at different parts of the head were duly noted.

Steel being, of course, a very rigid material compared with rubber, the distortion of the lines as the load increased was exceedingly small, and required very careful measurement to ascertain it accurately. The rubber model of Mr. J. D. Van Buren is therefore of particular interest as showing the effect of comparatively small increases of load on the material of the bar surrounding the pin. Fig. 1, annexed, is an illustration in diagramatic form of this effect. The dimensions of the rubber bar used for the experiment were: Neck, 1½ by ¼ in.; eye, 2¾ in. in outside diameter; and pin 1 in. in diameter.

The bar, as it appeared before the application of the load, is shown by the full lines with the full-line squares drawn on it. The dotted lines show the form which the bar and the squares took when the load was applied. The hole for the pin, after distortion, is shown by the dotted line *a b* E *d*, and the direction of the strains or flow are given by the slanting lines *f f*, etc. The corners of the squares, after distortion, are shown by the small dots. The stress at any particular point is denoted by the difference between the areas of the original and the distorted squares, or between their sides and diagonals.

It appears from the rubber model that the maximum stress is in the region of the pin along the lines *b* E and *d* E, where it is very great, as may readily be seen from the distortion produced. The stress along the outer edge from D to line 8 and from B to line 8 is not nearly so great. There is evidently a strong bending action on each side of the pin, just below the line B D, the tension at the pin being thereby increased, while it is reduced at the outer edges, a result that theory would have led one to expect. From the point *a* directly in front of the pin to the point A there is compression for about half the distance, after which there appears to be tension, and the top of the eye, above the lines 4 and 5, seems to act like a beam. At E there is compression, clearly shown by the distortion. Commencing near *b*, cutting *a* A below A and ending near *d*, there is a curved boundary of shearing stress surrounding the compressed area.

In addition to the change of shape, as denoted by the lines on the face of the head, there were also considerable distortions in thickness; and although it is not easy to formulate the relation between the distortions in the plane of the face of the bar and those in the direction of its thickness, the author of the paper considers that it may be quite possible from models such as he used to obtain a safe guide as to the shape of the eye that will give the greatest possible uniformity of stresses, and that, apart from the difficulties of manufacture, his experiments point to a head somewhat in the shape of Fig. 2 as the most suitable, in order to reduce the excessive distortion in the neighborhood of the pin. We think that perhaps Mr. Van Buren might even have gone a step farther, and thickened up the metal at the back of the pin, where the maximum stress comes, and not made it the same thickness as at the sides.

It is interesting to note that the distortions produced by various stresses in the rubber eye-bar, when compared by Mr. Theodore Cooper with those produced in large steel eye-bars, correspond exactly in character with those of the latter.

It appears from experiments both on steel and rubber eye-bars of the usual form that the elastic limit in the head is reached before that in the bar proper, and it is not difficult to see that this is due to the high compressive stress in front of the pin, owing to the small surface between the head and the pin. The bearing area between the head and the pin is usually considered to be that obtained by dividing the total tensile stress on the bar by the product of the diameter of the pin into the thickness of the head As, however, these pins never fit the holes perfectly, this method cannot be correct, the actual stress caused by the bearing of the pin being much greater than that given by this rule.

As is well konwn, the shape and size of the heads of eye-bars have often been varied in order to meet these excessive stresses, as, for instance, by adding material to the eye in front of the pin and adding certain percentages to the cross-section at the sides. The thickness of the head has also been increased above that of the bar. The use of harder steel for the head of the bar has been proposed, but this latter does not seem altogether practicable unless the bar itself be made of

the same material as the head, in which case the allowable unit stresses would be taken higher, and nothing would therefore be gained.

A way out of the difficulty has been suggested, which is to give the hole for the pin an oval shape, the shorter diameter being a little larger than the pin, and the longer diameter being sufficient to give the pin ample clearance. In order that the pin, when first brought into bearing, may not quite touch the front surface of the hole, but bear along the head at two places on each side, the curvature of the oval in front of the pin should be slightly different from that of the pin, and such that when a certain tensile stress is on the bar the radial compressive stress between the pin and the bar may be practically equal over an arc of 120 degrees. There appears to us, however, to be very serious practical

Fig. 1.

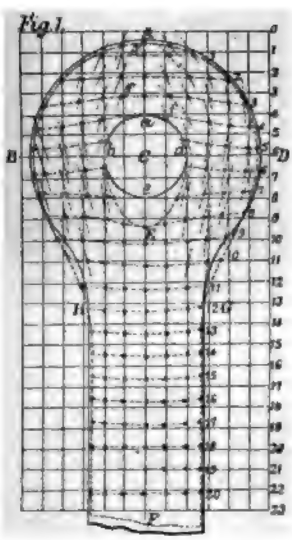


Fig. 2.

difficulties in the way of this proposition, and the method would, no doubt, add considerably to the cost of the bars. On the other hand, an eye-hole formed on these lines would no doubt considerably reduce the stresses around the pin, and, at the same time, the difficulty of inserting a pin through many bars in erection would be much lessened.

Distortions such as we have descirbed are, however, not confined to eye-bars, but are common to all connections where loads are applied more or less at a point, whether the members stressed be in tension or compression. All designs must to some extent possess this defect, which is unavoidable, unless there be *sufficient* material in the connection to distribute the stresses propertly. In a measure the difficulty may be overcome by thickening the heads, and also by making them elliptical, with extra metal behind the pin. In the days of iron heads this was the practice, and there are engineers who still consider (and we think rightly so) that when steel took the place of iron the elliptical shape should not have been departed from. It is not easy to see why the circular form should have been adopted for steel, when all experiments on iron bars seemed to show that the elliptical form was the right one.

The experiments to which we have alluded, although showing that the stresses in the head of an eye-bar of the usual form may be, and probably generally are, in practice, much higher than the stresses in the body of the bar, such liberal allowances are made in factors of safety that we do not consider there is the slightest ground for anxiety as to the safety of bars in existing bridges. Experiments such as those carried out by Mr. John D. Van Buren are, however, extremely interesting, and may prove of value and importance in computing the camber of long spans.—*Engineering, London.*

Laying Out a Right Angle with Tape or Cord.

One of the important problems that occasionally present themselves to maintenance of way employees is that of laying out a right angle, when great accuracy is required. Of course, there are few railway foremen who are unable to draw a line perpendicular to another free-hand, and not come pretty close to the exact direction. However, where long lines are to be sighted in a normal direction even an error of only one degree will materially affect the result. To illustrate, let the line A B represent any given direction and let it be required to find a line B C, so that the angle A B C shall be equal to 90°. If we consider the line A C drawn, then triangle A B C is right angled at B, and we know that in such a triangle the length A C squared equals A B squared plus B C squared. Thus, if A C is equal to 5, A B equal to 4, and B C equal to 3, we would have a triangle filling the requirements given: $5 \times 5 = 25$; $4 \times 4 = 16$ and $3 \times 3 = 9$; hence:

$$25 = 16 + 9.$$

If we would take a tape line and measure from B to A 4 ft., and take a string 8 ft. long,

making a mark 3 ft. from the end at C, then by joining one end of C, the angle at B will be 90°.

A convenient way to do is to make the complete triangle A B C by using a string a little longer than 12 ft. Make a knot at B a little more than 4 ft. from string to point A and the other end to point B, and by stretching taut at point the end and another knot at C just 3 ft. from the first, and then tie the two ends into one knot, forming point A; when done, check carefully by stretching and see that the three knots have the required distances from each other. If longer distances are required they may be provided for in the following manner: The three sides have the proportion of 3 : 4 : 5 to each other. So long as this proportion is maintained the triangle will have a right angle at point B. Thus, if we multiply the side A B, which we assumed 4 ft. long, by 10, it would be 40 ft.; also B C would be 3 times 10 or 30 ft., and A C 5 times 10 or 50 ft. This triangle would be right angled at B and would be more suitable if it was desired

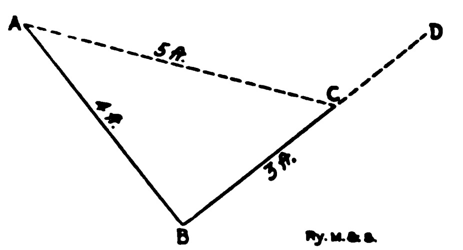


Diagram Illustrating Method of Laying Off a Right Angle with a Tape.

to extend the line B C beyond the point B toward D a considerable distance. The method described provides a satisfactory way to put down stakes for excavating, for instance, for building foundations, when no engineers are available to locate the lines. The writer once used this method in staking out a foundation wall 50 ft. by 125 ft., and when checked by a transit the error was negligible, the variation being not over 2' of angle from the true right angle.

When a 50-ft. tape line is available the triangle may be laid out directly by using as the sides 12 ft., 16 ft. and 20 ft. It must be remembered, however, that the right angle is always formed by the two short sides.—*Ry. Maintenance and Structures.*

Riveted Joints—Some Tests.

SOME time ago attention was called to the fact that difficulty was experienced in making tests to determine the shearing strength of rivets on account of the margin or distance from the edge of the hole to the edge of the plate tearing out, as shown in the accompanying illustration (Fig. O), instead of the rivet shearing. This immediately gave rise to some discussion as to whether the present specifications for riveted joints were not weak in this respect.

The gentlemen whose names are mentioned in connection with this article, therefore, took it upon themselves to make some tests to determine if they could not find some means of remedying this difficulty. The result of these tests we append below.

Two sections were prepared, using a standard design of triple riveted joint of ½-inch plate with 15-16-inch rivets in 1-inch holes, the plates being carefully fitted, holes reamed to size and rivets driven by hydraulic riveter, the joint being rated at 86.6 per cent of the strength of the solid plate. Two other sections were also prepared, being exact duplicates of the above, except that the margin or lap at the first row of holes was increased from one and one-half times the diameter of the hole, to twice the diameter, this being clearly illustrated in Fig. 1, of which plate No. 1 shows the standard joint, and plate No. 2 shows joint with the increased margin. After having these sections prepared it was suggested that another be prepared, as shown in plate No. 3, in Fig. 1, the design of joint being the same except that the section was cut to take in four rivets in double shear, instead of three, as shown on plates No. 1 and 2, the same width of section being maintained. This was done, two plates of this type also being made.

The accompanying sketch shows the design of both types in detail, while the accompanying table gives exact areas by micrometer measurements, and tensile strength per square inch of material used, also calculated strength, and strength developed by test. Fig. 2 shows method of failure of the joints. Tests Nos. 1, 2 and 3 in table correspond to plates Nos. 1, 2 and 3. Tests Nos. 3 and 5 are types shown in plate No. 3, Figs. 1 and 2; tests Nos. 2 and 6 in table are type shown in plate No. 2 in Figs. 1 and 2, tests Nos. 1 and 4 are standard joints as shown in plate No. 1 in Figs. 1 and 2.

Fig. 0.

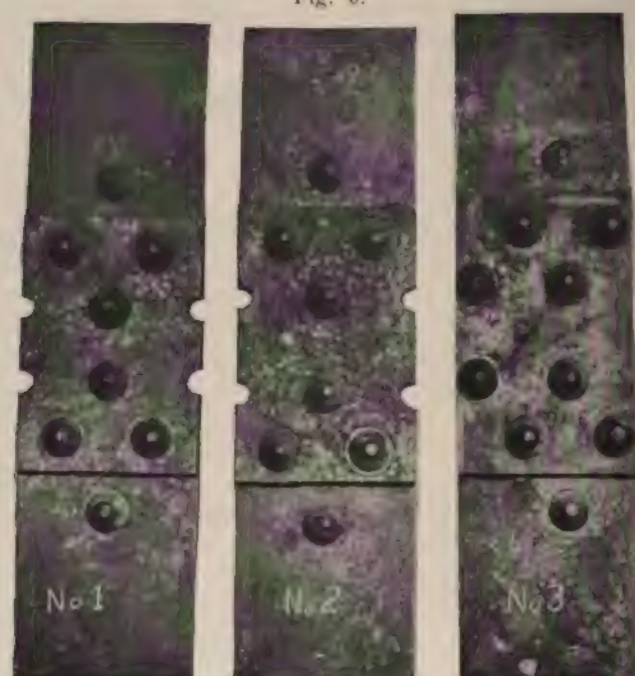


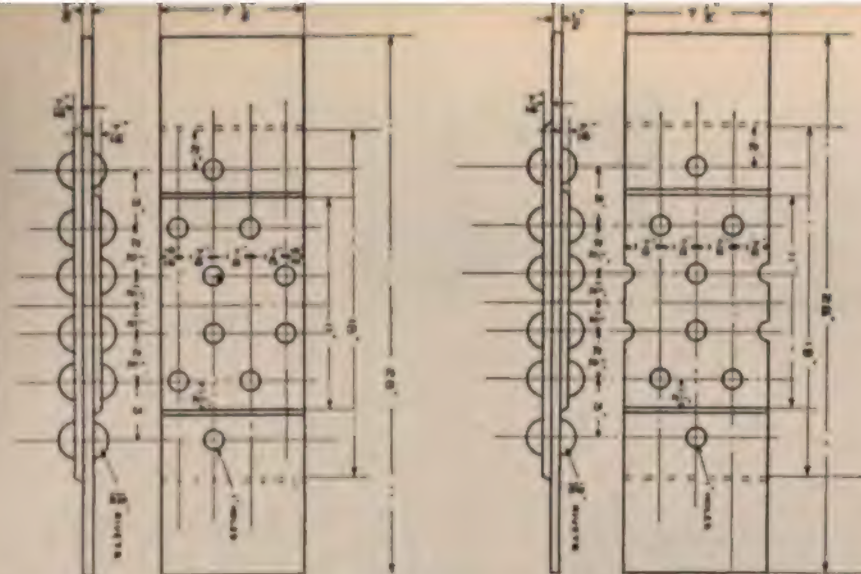
Fig. 1.

It will be noted by referring to the table, that tests Nos. 1 and 4 are developed within a small fraction of their calculated strength; test No. 2 also being well within an average limit, while No. 6 would hardly be called satisfactory, although the entire four ruptured at the back row of holes, which is the point calculated to break. It will be noted that while tests No. 3 and 5 also ruptured at this point, they fell 23 per cent below their calculated strength, this being attributed to the fact that the section was cut too near the rivet hole at the second row of rivets.

The conclusion arrived at by the committee was that while the generally used margin of one and one-half times the diameter of th hole is not of sufficient strength to shear single rivet in double shear, it is amply stron as used in the present standard joints whe reinforced by the shearing strength of th rivets in the second and third rows.

These tests were made very carefully unde ideal conditions by Messrs. E. L. Fitzsim mons, C. J. Murray and Tom Lyon, the gentlemen being assisted in their work by th engineer of tests of the Erie Railroad. Th above report was submitted at the conventi of the Master Steam Boiler Makers' Assoc ation at Chicago, September 4 to 7, 1906. Ryerson's Monthly.

Fig. 2.



DESIGN OF JOINTS.

TEST OF TRIPLE RIVETED JOINTS WITH DOUBLE BUTT STRAPS.

No.	Design of Joint.	Thickness of Plate	Width of Section Tested, Inches	Net Area Section Tested Square Inch.	T. S. per Sq. Inch.	Rated Efficiency Per Cent.	Calculated Str'gth of Section Tested Pounds	Ruptured at Pounds
1	Triple Riveted	.490	7.625	3.246	55,715	86.6	180,884	179,820
2	"	.483	7.406	3.093	55,715	86.6	172,325	168,640
3	"	.562	7.5	3.653	61,307	86.6	223,951	172,420
4	"	.480	7.5	3.120	55,715	86.6	172,830	172,480
5	"	.565	7.5	3.672	61,307	86.6	225,149	178,400
6	"	.493	7.625	3.266	55,715	86.6	181,965	172,300

Temporary Illumination in Engineering Work.*

ONE of the problems frequently confronting the constructor is the adequate illumination of work on which night labor is required. It is extremely difficult to get good results without good light, even supposing the roughest operations; and if skilled labor is to be employed after dark, as is sometimes necessary, first class illumination must be secured unless much work is to be wasted. One may even go further and say that such operations furnish one of the very few fields in which a large measure of light is advantageous. The reason is not far to seek, for almost all the materials of construction are dark in hue, the background of the earth is also dark and there are apt to be many local shadows. Not long ago the smoky kerosene lantern was about the only available resource in such cases, and the workmen were barely able to see their picks. It is small wonder that often such work runs high in cost when a contractor pays extra wages, as often happens, and then handicaps his workmen by making them work well nigh in the dark. The next stage came with the Lucifer and similar petrol torches, which are still in considerable and useful employment. They produce a powerful and economical light, but one which flickers badly and does not lend itself readily to use in contracted spaces or to concentration by reflectors. The next step came with electric lighting, and arcs secured from local companies have been largely and successfully, but seldom effectively and economically used.

To light a large space where miscellaneous work of construction is going on is no easy task. The main thing is to get a powerful illumination without dense shadows, and well distributed over the space employed. On the whole the best result is obtained by lighting as far as possible from above in order to keep the glare of powerful lights out of the workmen's eyes. The cheapest forms of light are in large units so that economy requires their use except in rare instances. A street railway working a night gang on its tracks probably has the best facilities for good lighting. It merely has to connect groups of five or six incandescent lamps in series under a tin reflector and hang the bunch to the trolley wire with the other lead on the rail. For even powerful light most convenient to the w this arrangement cannot be beaten. The a age engineer, however, has no such reso His choice is generally between using gas and taking lights of the local electric comp Probably the best and cheapest form of former plan is to use a group of mantle b ers, the so-called "gas arc," employing gas gas from a pressure tank. Using a flexible

Oil Lamp.

for connection such a light can be and sh be swung ten to fifteen feet up with an en eled reflector over it—moderately low in s areas, and higher in large ones where it is inforced by its neighbors. This is certa power for power, the cheapest light for t porary use, easily beating out the electric particularly the enclosed arc now used. new "flaming arc" occasionally seen in us our city circuits, is the only thing that beat the gas arc at its own game, but th now exploited at such fancy prices and electric supply companies are so loath push it on account of its enormous efficie that it cannot be considered as yet an avail source of light for ordinary use.

If in working over a big area, where v powerful lights are wanted, arcs can gener

*Article from Engineering Record. Illustrations secured by Browning's Industrial Magazine.

be supplied by a short run from the nearest local circuit. If a direct-current arc circuit is available, it is best to use the old-fashioned open arc, preferably fitted with ⅝-in. carbons if the hours of burning are not too long. Such arcs give very much more light for the same energy than do the usual enclosed arcs; and as they may be had second-hand cheap they may well be picked up by the wide awake contractor. They should be adjusted for about 6.5 amperes ordinarily, this being the current commonly carried in direct-current lamps. If only alternating current is available, it will be

The Buckeye Light, made by the W. McLeod & Co., Cincinnati, O.

necessary to be content with the ordinary arcs. In any case, arcs should be hung fairly high with reflectors over them, perhaps one arc to a space of 50 to 60 ft. square in the open, or spaced a little closer in narrow quarters where neighboring lamps do not much help each other. Arcs lend themselves readily to use with reflectors and in certain cases where they are not easily placed near the work, should be thus fitted. They should be used not singly but in pairs so as to give cross lights on the working space, thus decreasing trouble from shadows. In case reflectors must be used where an electric circuit is not available, a portable acetylene generator is the best source of light, being better in such case than the gas arc, although rather more costly. Reflectors of both wide and narrow angle should be available to meet the cases of a wide space or a deep excavation. With a few acetelyne outfits and a number of gasoline equipments, the engineer can meet almost any exigency without calling for electric circuits. Eventually when the flaming arc comes into more com-

THE WELLS LIGHT BURNING KEROSENE OIL.
The Wells Light Mfg. Co., N. Y.

mon use it will be extremely well fitted for temporary works, and the small portable electric outfits may be thus utilized to very great advantage. Indeed, in many situations such a plant, with, say, a 5-kw. generator, is extremely valuable to the contractor and can be worked at very moderate cost. Whether gasoline or electricity is the main reliance, the chief thing is to give steady light and plenty of it. It is easy to lose $5 in labor while saving 50 cents in light.

These lights use either kerosene oil, highly inflammable gasoline or naphtha, and may be used for either heating or lighting. One size of 200 candle-power burns 1½ gallons of ordinary kerosene oil in four hours.

Turpentine and camphor are generally used as lubricants for drilling glass, but a simple solution of soap in water answers very well.

The Possibilities of Concrete Concrete Construction from the Standpoint of Utility and Art.

BY WILLIAM L. PRICE.

IT is not my purpose to dwell especially upon the use of cement in the purely engineering side of building, although I believe that its use in that direction is in its infancy—and the general problem of concrete for heavy foundation work and reinforced with steel for structural work, has been covered by experts in those arts.

The accepted use of reinforced concrete as a structural material does, however, open up a field in architectural design that has been little considered. We have, both here and abroad, a comparatively large number of concrete buildings which are structurally good, but in most cases they are treated merely as a skeleton on which a building apparently of brick or stone is hung—a makeshift and a sham, whether the actual work is done by structural steel or a concrete frame developed therefrom.

But reinforced concrete used even as a skeleton offers opportunities for design not offered by any other material. A steel-frame building is no stiffer than its joints, and in buildings of greatly varying heights or loads allowance must be made in design to take up undistributed settlement, or serious cracking will result. While in concrete the building, if properly designed structurally, and properly built of proper materials, is a monolith.

In the Blenheim Hotel, at Atlantic City, we have an exaggerated case of uneven loading. The Solarium is but two stories high, it covers an extent of 150 by 120 feet, it immediately joins the main structure which leaps at the juncture to twelve stories—a height to the dome of 155 feet, and next adjoining this mass is the main building, eight stories high, surrounded by outlying sun parlors and banquet rooms of two stories. And yet, in spite of this divergence in loads and the fact that this work was not all built at one time, there is not an eighth of an inch settlement in any part of the building. A steel building on the same foundations would probably show at least three inches of settlement, and it would not be safe to count on less.

It is my opinion that a considerable area of this building could have the foundations washed out without damage to the structure, nor does the heaviest wind so far encountered cause a perceptible vibration, even of the highest part of the building. These facts are not new as facts in engineering, but as architectural facts and inspirations they have been largely ignored. But if the cement manufacturers will stand by the architects this will come. Any falling off, however, in the quality and reliable characteristics of cement will be fatal, as a concrete building is either the best or the worst of constructions, and primarily the cement is the vital point, so that the cement man's first business is with himself. But while his responsibility may end there, his interests do not. The best of cements may be improperly or dishonestly used, poor sand, poor stone, poor mixing and placing alike will damn the construction, and it is in this direction that the greatest danger lies, and this danger is an imminent one. If buildings are to be designed by incompetent or ill-informed engineers and architects, no matter how much they know of design in other directions, the result will be disastrous, both to the cement men and to those among the architects who believe in the future and possibilities of cement.

It all looks so easy, just the building of boxes and the casting of concrete and steel in the moulds, and where the law, or, better, knowledge, does not protect us, all sorts of liberties are going to be taken, owing to the desire to save materials and the large factor of safety usually and properly allowed.

To illustrate, when bids were taken on the Allegheny City Station of the Pennsylvania Railroad a number of bids were received, varying considerably in amount, and, while the specifications called for 16,000 pounds stress upon the steel and 500 pounds on concrete, we found upon questioning the bidders that some of them had computed their steel as high as 22,000 pounds, and their concrete at 750 pounds. In fact, they were entirely frank about the matter, stating that there was no law in Allegheny on the subject, and that it was amply strong. Nor had they at all considered it incumbent on them to use the stone specified. Now, if this is to be the tendency of even large and reputable contractors, I can see grave dangers ahead, both from the effect of failures upon the public, and the passage of too stringent laws.

I turn from the dangers to the possibilities

of the material architecturally. I cannot see much sense in the use of concrete as a substitute for block building material, although it will probably have its place if it is frankly treated as concrete and not as imitation stone. But the possibilities of design in concrete used this way are those of its competing materials, stone, brick and terra cotta, so that I shall not dwell upon that, but try to point out something of what seems to me to be its greater possibility as a plastic material.

In block building, whether of stone, brick or other material, the joints are an essential element of building, and as such should become an essential element of design to be accentuated rather than hidden, and in all characteristic and good architectural design you will find recognition of this fact. Take, for instance, any of the classic orders or their modifications in the Renaissance, and you will find a frank succession of blocks and columns set upon plinths, or directly on basement wall, cap, abacus, frieze and cornice, all built up stone upon stone with major joints marked by mouldings, bands and ornament, a logical, built structure. But if we attempt to follow such a system of design in a plastic material, or even a material like wood, the results are disastrous to true architecture. The design becomes a matter of external form, not of the true expression of methods and materials used. Concrete is built with shovel and trowel, and its proper ornamentation should be either cast in moulds as built or such as can be run or fashioned on the work, with the addition of such color ornament as may be obtained by the use of terra cotta or other protecting material used as wall copings, roofs, pier caps, etc., and such other flat color ornamentation as may be produced by the use of tiles, marble glass or other material which is evidently applied to the surface. It is evident that this would and should make a wide departure from classic forms and accepted styles, that it means in fact a new architecture, although it will not be necessary to abandon all precedent. We shall want walls, windows and doors in any case, and must learn to build them in their accepted forms. But in a material so plastic the forms of openings and mouldings may be expected to vary much from those necessary to an architecture dependent on arches and lintels. There is more to be learned in the Spanish, or Californian and Mexican varieties of Spanish, than any other accepted type. Their plastered walls, tile roofs and wall copings suggest concrete more than they do brick, and their domes and curved pediments are already suggestive of plastic rather than block construction.

I may perhaps be permitted to refer to the Blenheim Hotel as an example of an attempt to carry out some of these thoughts. At least there is no suggestion of built structure in its simple wall openings, its exceedingly few and simple mouldings, and its total lack of cornices. We have distinctly tried in it to use a solid wall, pierced by the simplest of openings, in an effort to reduce to a minimum the chopped-up appearance common with buildings that of necessity have many windows and small unbroken wall spaces. We have attempted, even where the wall was broken still further by bay windows, to preserve this feel of wall and have used the shadows thrown upon this broken surface by balconies, to give the relief usually obtained by ornamented cornices, and with the addition of a tile roof and some beautiful color obtained with Mercer tile, we have secured sufficient color and variety to make a building essentially plain in wall surface, give a sense of richness not always obtained by the use of elaborate and expensive ornamental work in stone or terra cotta, and the use of a moderate amount of terra cotta where required for sills, copings and other wall protection, has been made unusually important by modeling it in interesting and appropriate sea forms and coloring it a light green, by a glaze which has the additional advantage of destroying any semblance of stone and giving it a plastic character that seems appropriate to modeled ornament. It is along the line of simple and direct expression of the purpose and mode of construction of building that architecture grows when it is really growing, and cement in its manifold possibilities spreads before us a new field for the imaginative designer.

The average composition of pewter of former times was as follows: Tin, 84; lead, 10; antimony, 5; copper, 1. By far the greatest quantity of pewter which is now bought and sold is "britannia metal" and contains no lead. Old britannia metal and old pewter cannot be distinguished by appearance. The reason that britannia metal has practically replaced true pewter is because it has been found unsafe to use cooking utensils of an alloy which contains 10 per cent of lead.—*The Eng. and Mining Journal*

News Items.

The De La Vergne Machine Company, foot of East 138th street, New York City, has just issued a folder describing the Klein water cooling tower built by them. These towers will cool the water to from 5 to 15 degrees below the temperature of the atmosphere.

The Manufacturers' Advertising Bureau formerly at 126 Liberty Street, New York City, but now at 237 Broadway, find their new location a most desirable one. Their facilities for handling the steadily increasing business which comes to them are much improved and manufacturers who intrust their advertising interests to the care of the Bureau may be assured they will be well looked after.

The present offices of the Manufacturers' Advertising Bureau are located opposite the New York City Post-Office and convenient to the subway, elevated roads, the ferries and Brooklyn Bridge. The Bureau is one of the recognized business institutions of New York City and headquarters for everything in the way of trade and technical advertising.

Steel Barges for Carrying Coal.

The Manufacturers' Record, of Baltimore, says that a new and most promising use for steel is the construction of steel barges for the shipment of coal on the Ohio and down the Mississippi Rivers. A number of barges are now being built at Pittsburg by large coal operators, with a view to carrying coal down the Mississippi and to Habana and other West Indian ports without breaking cargo. It is estimated that there are about 11,000 coal barges on the rivers, and with the start made for the substitution of steel for these wooden barges it is believed that there will be a very rapid change and that there will soon be an enormous fleet of steel barges handling coal on the Ohio River and its tributaries for shipment to Europe, to the West Indies, and to Central America.—*Engineers' Review.*

The Canadian Northern Railway and associated interests have in contemplation the establishment of blast furnaces, rail mills, and other industries on a large scale in Toronto. They have applied to the city to ascertain if a site suitable for this purpose of about 50 acres in extent is obtainable on Ashbridge Bay, in the eastern section of Toronto.

The Suppression of Smoke from Steam Boilers.

Discussion of a Problem of Wide Interest.

BY A. BEMENT.

THE problem of burning bituminous coal without producing smoke can be divided into distinct features—one referring to legislation and its enforcement, the other to the technical or engineering phase of the matter, and it is more particularly the latter feature that is considered in this paper. It is my wish to emphasize certain fundamental principles upon which the complicated and difficult problem of smoke production and suppression rests, rather than attempt the detailed treatment of any individual condition or set of conditions.

It is a recognized fact that bituminous coal can be burned without smoke; also that the consumption of the volatile gases results in increased economy, and while great improvement has been made, there is very much still to be accomplished; and the great and foremost requirement is a technical one, demanding not only a recognition of the principles involved in smokeless combustion, but better engineering practice as affecting design of plants and furnace apparatus. I believe the people who are to blame for present conditions may be divided into three classes in the order of their responsibility:

First—Manufacturers of furnace apparatus.

Second—Consulting engineers and architects.

Third—Purchasers who operate the apparatus.

In considering the matter from the standpoint of manufacture, the important fact should be emphasized that with one possible exception there is, strictly speaking, no smokeless apparatus made. This single exception will be mentioned later; but it is first desirable to outline the requirements governing smokeless combustion. They are:

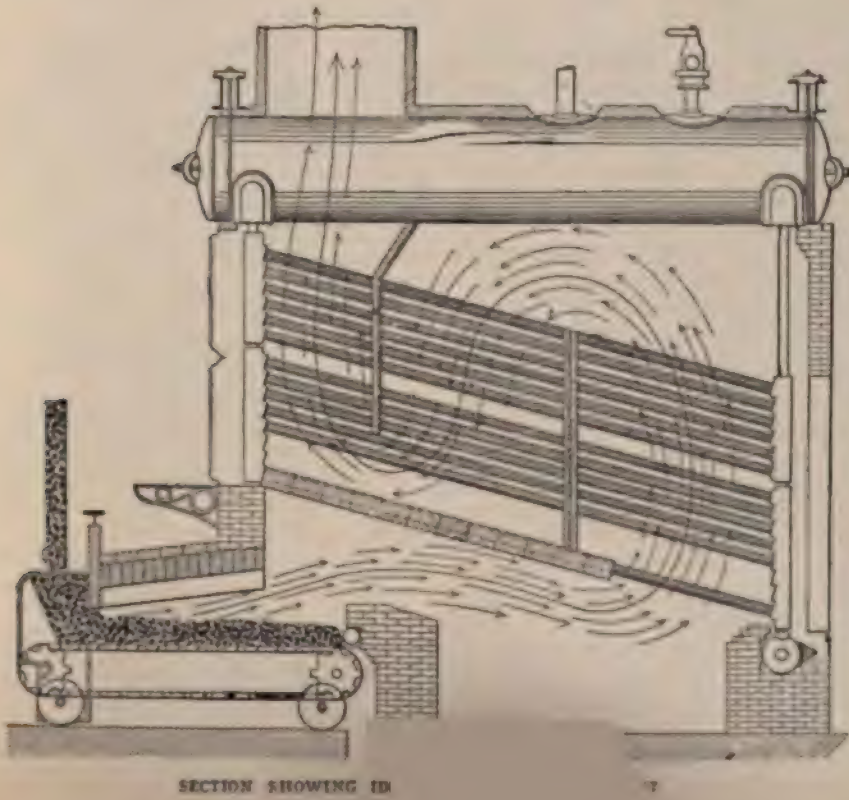
First—Uniform evolution of the volatile gas, which requires a stoker with a positively uniform feed of coal.

Second—The location of a chamber of sufficient length or capacity between the fire grate and exit to the boiler to insure that the volatile gases shall become thoroughly mixed with the air which enters with them.

Such chamber, which I have called a furnace, to distinguish it from the grate, must, of course, be made of refractory material to enable it to withstand the heat, and its walls necessarily become red hot; this has caused many people to believe that the high temperature in itself was the cause of the volatile gases being burned, failing to take into consideration the fact that the most important requirement is a thorough mixing of the gases with the air in the chamber. Failure to realize this fact has resulted in disappointment with many brick arches, "Dutch ovens," etc. The chain grate, owing to its feed of coal being on a horizontal line, insures a positively uniform rate in the feed, and consequently there is a steady evolution of the volatile gas, which will be burned if there is such furnace located between it and the boiler, and this apparatus may properly be called smoke proof, because it is impossible for the operator to either cause, or allow the coal to be fed in other than a steady and uniform manner.

Even when a very large furnace chamber is used with any form of stoker (other than a chain grate) or a hand-fired grate, a smokeless condition is dependent upon careful manipulation. For example, with a hand fire, if too much coal is added at one time, the evolution of gas will be greater than the mixing capacity of the chamber; or, with sloping grate stokers, when a large quantity of coal is poked or slides down the grate, the result is the same as when a large charge of coal is added to a hand fire. Thus the fuel-feeding apparatus or method of manipulation, must not overtax the mixing capacity of the furnace chamber, if a smokeless result is to be secured.

The accompanying illustration shows the latest and best type of smoke-proof steam generator, its furnace chamber being formed by tiles covering the lower row of the tubes of the boiler. It is not a patented apparatus and may be adopted by anyone who wishes to do so. In fact, many boiler plants now installed may at small expense be altered so as to conform to all of its essential requirements. While this particular improved apparatus has already been built when demanded by pur-



SECTION SHOWING ID[illegible]

chasers, no manufacturer is willing to erect it unless required to do so. The nearest approach to a smoke-proof apparatus in the form of a complete steam generator, offered by any maker, consists of a brick arch as an essential adjunct for the direction of the gases against the tubes of the boiler, and when this manufacturer installs a chain grate under this arch, it becomes the above mentioned exception to the rule. This does not mean, however, that a purchaser may not buy a boiler from one maker, a stoker from another, and with a little engineering produce an apparatus which is strictly smokeless, but that an entire apparatus of satisfactory character as a unit, cannot be purchased from any other manufacturer.

For a clearer understanding, it is essential that furnace apparatus be considered in two classes, one which is smoke proof, the other depending upon careful manipulation for good results. This latter class may also be separated into two divisions, those which by reasonably careful working will be smokeless, and others, which it is very difficult to operate without smoke. Thus there are three grades of apparatus, the perfect, the moderately good and the bad.

The effort of health departments and smoke-inspection bureaus should be to enforce the adoption of the perfect apparatus, proper manipulation of the moderately good and the abandonment of the bad. Unfortunately, however, the most serious offenders—the manufacturers, consulting engineers and the architects—are not affected by the smoke laws, therefore can only be reached indirectly through the purchaser who bears all of the burden. Thus the only alternative is to enforce the laws in such manner as to be most effective.

The position of the smoke inspector from the engineering standpoint is a difficult one. As a general rule he is an administrative official, appointed or elected for the purpose of enforcing laws, and his time and efforts are taken up in such work, and the character of the requirements largely determines the training of the man selected. It necessarily follows that often he is not an engineer, at all events to that extent necessary for the solution of the difficult engineering problems encountered; the conditions under which he must necessarily work prevent to a very great extent his becoming technically proficient, because the tendency would then be for certain apparatus to be recommended in preference to others; this immediately results in trouble, caused by the influence of manufacturers who would not be favored. As it is, if a prospective purchaser applies to a smoke inspector for information as to the most desirable apparatus to be procured, he may be referred to a number of plants which are examples of good practice, in which he may find a variety of apparatus, and selecting one of these, often finds after it is in service, that under his conditions it is not satisfactory; upon further investigation, he discovers that others labor under as much difficulty as he, and thus often feels that he is an innocent victim of circumstances.

There are many plants where conditions render it difficult to correct the apparatus except at great expense. Such cases present a real problem to the smoke inspector. On the other hand there are many owners who do not try to improve conditions, in fact, make no effort to discover whether or not they can correct their practice or the apparatus, and make promises they do not intend to fulfil. One of the most common excuses is, that their boilers are "overloaded" and for this reason they can do nothing, and unless the inspector is an engineer and familiar with this phase of the matter, he often encounters a seemingly insurmountable difficulty, when in reality these same owners, for reasons of economy, would not work their boilers at a lesser capacity. As a matter of fact, the practice which insures a smokeless condition also results, as a general thing, in the production of a large capacity. The remedy with such owners is a drastic enforcement of the law.

In view of the fact that the greatest trouble is one that may be overcome by better engineering practice, and that there is no accepted or recognized independent source of information for the guidance of well intending purchasers, it is recommended that the various experiment stations connected with State universities and the different State Geological Surveys, present information to the people of their respective States, which, coming from such sources, would be accepted with confidence and used to advantage.—Eng. & Min. Journal.

In estimating fuel consumption for hoisting engines and contractors' machinery, one-third of a ton of coal may be allowed for each 10 horsepower per 10-hour shift. This rule is shown by practice to be a fair estimate for engines up to 80 horsepower.

THE DESIGNER AND DRAFTSMAN.

Three-Ported Slide Valve for Low Pressure Steam Cylinders.

From the German; by Max Kurth.

THE "*Zeitschrift des Vereins deutscher Ingenieure*" recently described a 3 ported valve, designed by Mr. H. Hachwald, Berlin, Germany.

The special features are excellent steam distribution and small stroke whereby very little effort is required to move the valve. Besides this, the valve automatically adjusts the final compression according to the receiver pressure.

For the inlet, the valve has a trick port *t* and a port *K* which separately for each valve end effects inlet and exhaust. The exhaust port *m* is provided with the web *O* and the lap of the edges *X* is always negative.

The inlet ports *d* of the cylinder are not parted while there are 3 exhaust ports leading into the exhaust chamber.

These 3 ports in the mid position of the valve are closed by the bridges of the latter, which govern the exhaust. Projecting into the exhaust chamber *g* is built chamber *c* which is in connection with the steam chest and which therefore is always filled with working steam.

By virtue of this design, the valve forms 3 inlet passages, 3 exhaust passages and passages to allow the steam to flow from one cylinder end to the other in order to regulate the compression by equalizing the steam pressure.

FIG 1.

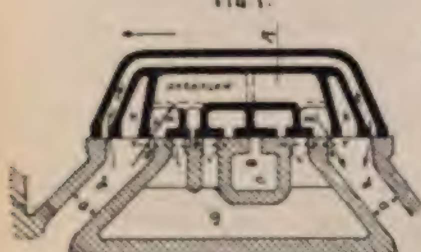


FIG 4. SECTION AB

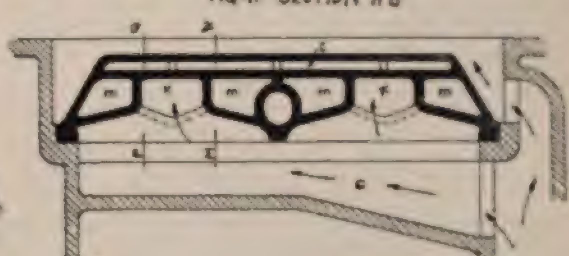


FIG 2. SECTION M-N

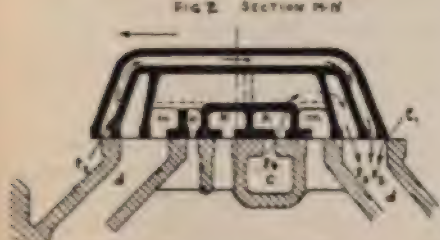


FIG 3. SECTION P-Q

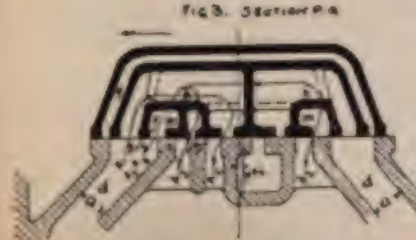


Fig. 1 shows the valve in its mid position. The steam flows through the valve ports and in to the other side. Before this overflowing takes place the port *m* was constantly in connection with either the condenser or atmosphere, thus assuring a sufficient quick flow from one cylinder end to the other whereby the pressure is perfectly equalized, even at high rotative speed.

Fig. 2 shows the begin of the inlet on the right cylinder end, the inlet passages being indicated by arrows. As per *E*, live steam enters directly from the valve chest, E_2 indicates the flow of steam through the trick port *t* while port *K* admits steam as per E_3.

There are also 3 passages for the exhaust A_1, A_2 and A_3 (Fig. 3). The passage A_1 is

formed by the valve port *K*, the two others by the port *M*. The width of the exhaust port is that which is formed by the space between the edge *X* of the valve and edge *Y* of the cylinder and amounts to $W = S + i$.

With the motion of the valve, the opening of the 3 exhaust passages increases uniformly up to the position where the stroke of the valve reaches the amount $W = 1 + (s + i)$ whence the port opening A_3 remains constant, while A_1 and A_2 continue to increase till the maximum port width *a* is obtained.

$$\text{Then } W = 1 + \left\{ \frac{a - s + i}{2 \quad\; 2} \right\}$$

Beyond this, the exhaust port remains open to its entire width until the valve begins its return stroke.

Fig. 3 shows the Zeuner valve diagram for a 3 ported valve as applied to the low pressure cylinder of vertical engine. The curves of the port opening for inlet, overflow and exhaust are shown in the diagram.

The diagram shows clearly how rapidly the closure of inlet and exhaust ports is effected. The exhaust port is entirely open shortly before the piston reaches the end of the stroke, therefore the back pressure even for the maximum load and high rotative speed, drops nearly entirely down to exhaust pressure without necessitating any change in the point of release. The cards as per Fig. 5 and 6 clearly show the excellent steam distribution.

When running condensing, the overflow also increases the work of the steam as the steam after expanding flows over to the compression end, there filling the clearance spaces and effecting high terminal compression at the expense of very little work.

As the overflow effects compression to suit the receiver pressure, it is obvious that no changes on the valve gear are required when either running condensing or noncondensing.

The cards Fig. 5 and 6, taken from the engine when running condensing are compared with those Fig. 7 and 8 from the same engine running non-ondensing, the latter showing clearly the decrease of compression.

Compared with other multiported valves, the frictional losses are considerably smaller due to the peculiar steam passages.

The steam overflow also acts to balance, as the steam fills all the valve passages thus reducing the pressure by which the valve is pressed against its seat.

As compared with the well known double ported Penn valve for instance, the stroke of the Hochwald valve is 25% and the non-balanced area from 22 to 26% smaller than that of the Penn valve.

Elevators.

BY L. E. VATOR.

AT the present time literature relating to elevators or lifts is rather scarce. Beginning with the present article the writer intends to write a series touching the various types of elevators, as well as various details of the machines and hoisting apparatus as made by different concerns. While it is not the writer's intention to dwell at length upon any one thing it is intended that what is written will be of service to the operating engineer, prove of interest to the designer, and even catch the attention of any building contractor or architect which the magazine may reach.

Of the types of elevator machines it may be said that they are many and various. There are hand-power machines including small dumbwaiters with a capacity of five pounds to carriage lifts that can handle a load of 5,000 pounds. Also the belted type where the motive power is transmitted by belts to the machine, the belts being driven from the same shaft that furnishes power to other machines.

Then there are the machines using steam as the motive power and handling loads of any weight likely to be received by a freight or passenger elevator. In these machines the steam engine may be belted to a pulley on the worm shaft, or the worm shaft may be a continuation of the crank shaft. Or there may be a combination of steam and water as in the steam-hydraulic machines where a plunger or piston as in the ordinary hydraulic elevator is forced up and down.

For examples of hydraulic machines there are the plunger hydraulic elevator where water entering and leaving a cylinder forces a plunger up and down, the car being secured to the end of the plunger. Also the inverted and pulling plunger types where the car is connected to the plunger by cables and where multiplying sheaves may be used to give high speeds at the car with a slow speed at the plunger. Then there are the vertical and horizontal tension and ramming types which also use multiplying sheaves to give the car a high speed.

Of the various types of electric machines

there is the electric-belted in which power from an electric motor is transmitted direct from the motor pulley to the pulley on the worm shaft of the elevator engine. The direct connected electric machine has the armature shaft of the motor coupled directly to the worm shaft of the machine. The traction machine which is coming into prominence for high speed installations uses two motors having the hoisting ropes running over pulleys keyed to the motor shaft. In New York City there are quite a few Sprague-Pratt screw machines still in operation. These are for high speeds and consist of a long screw coupled directly to the armature shaft of the motor. A traveling nut on the screw carries several sheaves. The hoisting ropes weaving over these traveling sheaves and over stationary sheaves at the end of the machine gives the speed multiplication necessary for high speed.

The class of service, amount of space that can be allowed the machines, the first cost, the running cost, and the liability to get out of repair are some of the points to be considered in determining the type of machine and what the motive power shall be. However, even the elevator business is not free of fads and at present in New York it takes good, solid work to sell any but a plunger hydraulic machine for any class of work.

The type of machine to be used is usually determined by the architect in the case of small buildings, and by the mechanical or consulting engineer in the case of large installations. In general it may be said that a common drum machine of the direct electric type would not be chosen for car speeds over 400 feet per minute; but a traction or high speed hydraulic machine would be used. A belted machine would never be specified to haul the cars in a large office building; but sometimes in small cities and in out-of-way holes where cheapness or low first cost is the object, a machine of this kind is found. For light freight work in a factory these may do very well, but a direct electric or plunger hydraulic would give better satisfaction. For moderate speeds and loads, and especially for private house work the direct electric machine has the preference. The push button system of control doing away with any attendants, and giving a machine which can be run by anyone able to read figures and press a button is the great advantage the electric machine has for residential work. If there is a case where, say 25,000 or 40,000 pounds is to be handled at a car speed of about 50 feet per minute, the hydraulic plunger machine is the natural choice, and when used in connection with a Quimby Screw Pump direct coupled to an electric motor, an ideal lifting plant results.

Table I, which gives the loads and speeds of various direct electric machines together with the class of work, will serve to give an idea of the work demanded from electric machines. The table is strictly up-to-date and represents the best of modern practice being made up from the records of some of the electric machines installed within a year by a prominent eastern elevator company. Under "Control," "Automatic" means the push button system. "Car" means that the operator controls the machine by a car switch. Under "Office Building" machines it will be noticed one is marked as being backgeared to lift 5,000 pounds. The backgeared machines are arranged so that a spur gear can be put in mesh which acts as the backgear on a lathe, and enables a larger load at a lower speed to be handled. This provision is made for handling safes, or other heavy material being put into the building.

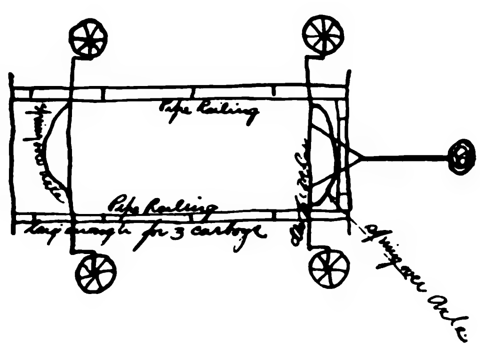
TABLE No. 1.

Where Installed.	Service	Low Speed.	Load	High Speed	Load	Control.
Factory	Booklift	200	150	....	....	Auto.
"	Dumbw'tr.	150	200	....	....	"
"	"	250	100	....	....	"
"	Freight	80	4000	....	....	Car.
"	"	100	4000	....	....	"
"	"	100	6000	....	....	"
"	"	75	4000	100	2000	"
"	Passenger	125	2000	....	....	"
Hotel	Dumbw'tr	50	500	....	....	Auto.
"	Freight	175	4500	250	3500	Car.
"	Passenger	180	2250	275	2000	"
Office Bld'g	"	300	2000	....	....	"
* "	"	200	3000	350	1800	"
"	"	125	2000	....	....	"
"	"	350	2500	....	....	"
"	Freight	80	3000	125	1800	"
"	"	150	4500	....	....	"
Store	Sidewalk	50	2500	....	....	"
"	Passenger	150	2500	200	2000	"
"	"	200	2500	....	....	"
"	Freight	100	3000	150	2500	"
Hospital	Dumbw'tr	100	400	....	....	Auto.
"	Passenger	200	2000	....	....	"
Public bldg	"	350	4000	....	....	Car
"	"	180	2250	275	2100	"
"	"	240	3000	300	2000	"
School	"	200	4500	....		"
Priv House	Dumbw'tr	100	100	....	....	Auto.
"	Passenger	100	800	....	....	"
"	"	100	1000	....	....	"
Apartme'ts	"	180	1500	....	....	"
"	"	130	2250	150	1900	Car.
Op House	"	150	7000	240	2000	"
....	Auto. Lift	50	5000	100	6000	"
Ry. Station	Baggage	50	6000	....		"

*Backgeared.

A Letter and Sketch Received by a Manufacturing Firm.

Dear Sir: Our increasing demand for acid seems to call for something more modern in the form of a vehicle for the transportation of same, we have only this two-wheeled affair that will hold only two boxes and quite frequently two parties from different ends of the mill come after acid at one time. For example, one party wants one carboy and the other two carboys. Of course you see one set of men wait until the others return, and I also have to wait when I could be doing something else. Now if we had a low wagon, wide enough for one box, and long enough for three boxes, I believe it would be quite a good thing for us, they could carry them right along at one time very easily. I would suggest a wagon as light as practical with springs underneath to avoid breakages while crossing the car tracks, and it could have a pipe railing around the top to hold them in position.



There is no question but what it would pay for itself, in time and breakage, in a short while.

Our present wagon is very high and some of the men who are very small of stature, with their muscular development and ambition still smaller and they have considerable difficulty in getting the carboys safely landed. I will draft an outline of a wagon on another paper and perhaps you could suggest something much better.

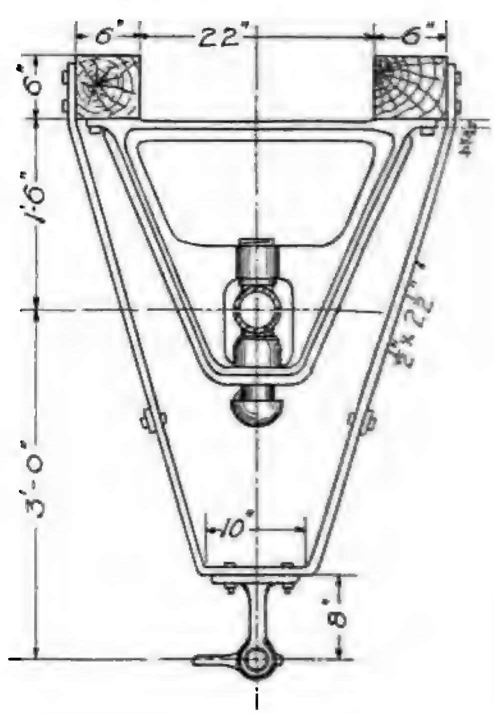
Yours very truly,

Cooling Steel Castings.

Many steel castings may not be allowed to cool in the open, or even in the sand, without danger of spontaneous rupture from internal strains, but must be placed while still hot in a heated receptacle, usually a furnace, and allowed to cool with the furnace at a much slower rate than if in the open air. Steel wheels, as well as iron car wheels, usually require such treatment, though the ductility of the softer grades may admit of its omission. On the other hand, the greater coefficient of expansion of steel tends to set up greater strains than those of the iron wheels.

A Countershaft Hanger.

A neat design of support for the hangers of a small countershaft is shown in the sketch. The countershaft was used for a small lathe which was placed almost directly under the main line of shafting.



The support for the countershaft was made of flat iron ½"x2½" with two connecting pieces of ⅜x1½, to which the shifter lever was attached.

It makes a very complete support for a light countershaft.

Parallel Motion on Drafting Board.

Browning's Industrial Magazine:

Gentlemen:—In the September issue of your magazine you illustrate a parallel rule attachment for the drawing board which I think is rather trappy and too much in the way when in use.

I enclose sketches of one in use in our office.

It is always in order and works fine on all occasions, besides having the advantage of being cheap to make.

The only parts that wear out are the string and the rubber band.

It is in use on boards 18"x26"x½" thick and also 26"x40"x1" thick, and can be used on most any size up to the draftsman's limit.

The drawings explain themselves so I will not go into detail.

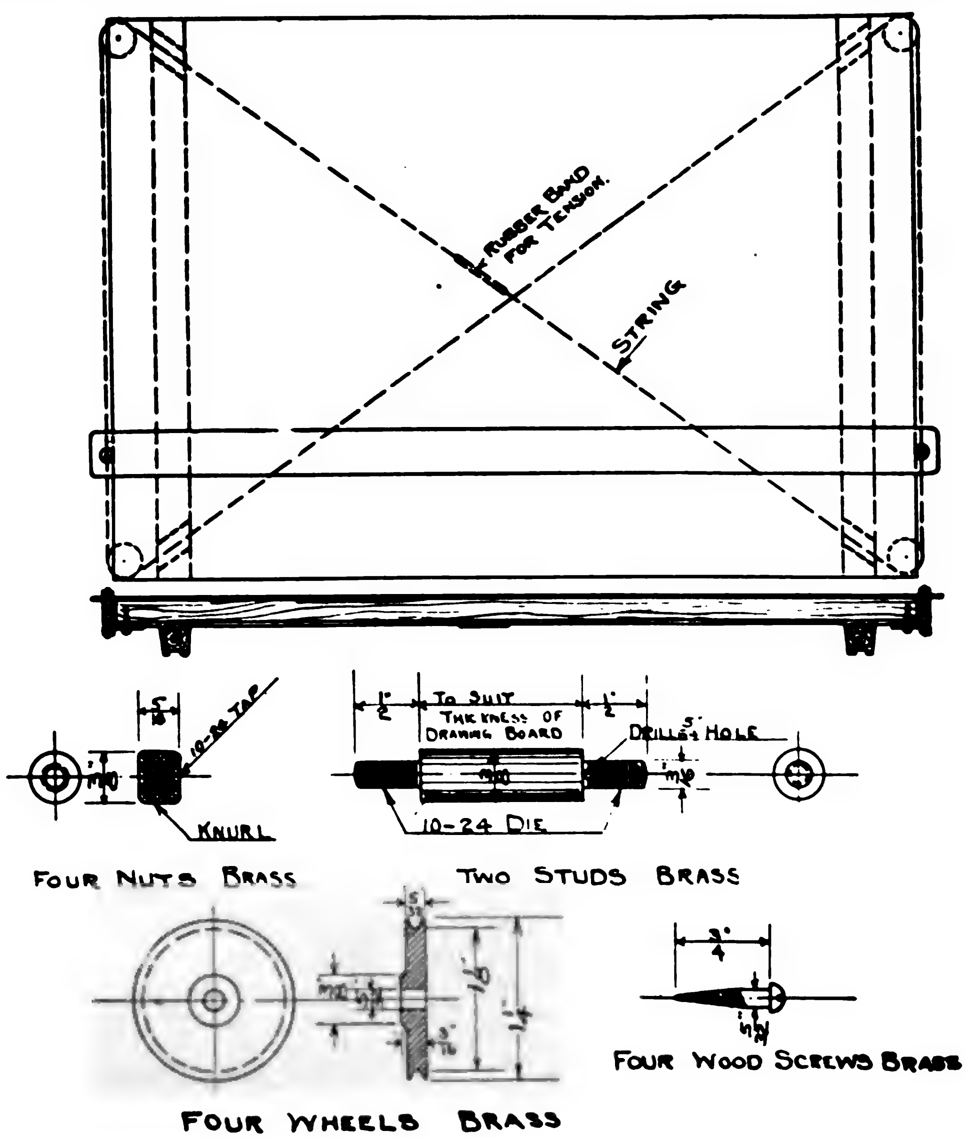
If you want to have me send you copies of my tables on Gearing and Bolts and Nuts let me know and I shall be pleased to do so.

Have received the last three issues of the paper and am much pleased with the same.

Hoping that you will find the sketch available, I am

Yours very truly,

E. C. FALK.



A Suggestion Which Will Be of Assistance in Drawing Irregular Curves.

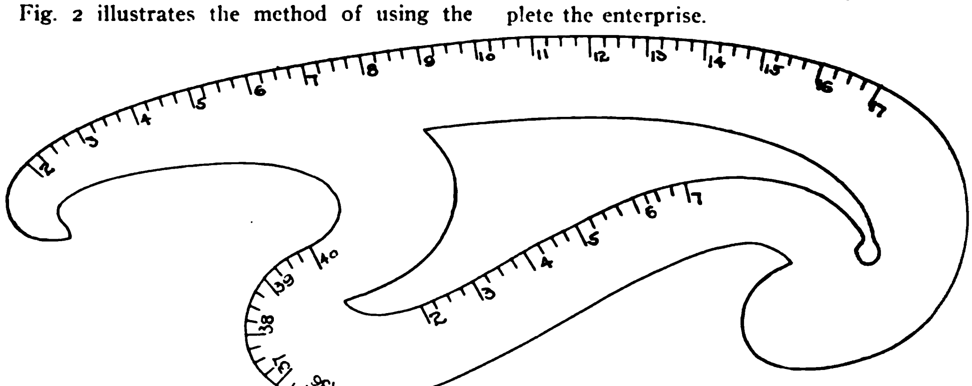
MANY of the curves which are drawn by means of the French-curve are symmetrical, especially the geometrical figures—the ellipse, the hyperbola, and the parabola. Therefore in drawing one of these figures it is necessary to use the same parts of the French curve on either side of the axis of symmetry. The regularity of the curve and the degree of perfection of the symmetry will then depend on one's ability to reproduce in proper sequence on one side of the curve the parts of the French-curve used in drawing the other side first.

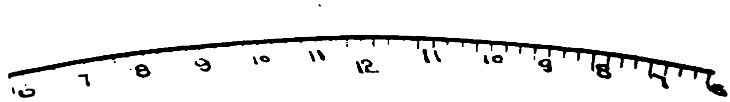
Fig. 1 is a sketch of a French curve, graduated on its inner and outer edges in abitrary division, say ⅛". At every fourth one of these divisions a number is placed, starting with one at any convenient point on the curve and increasing by one until the graduations come back to the starting point. If the curve is made of celluloid the figures may be put on in black so that when the curve is turned over with the figures down, they can be seen readily. If the curve is made of an opaque substance the numbers must be put on both sides. The numbers on the back should exactly coincide with the numbers on the face, and should proceed around the curve in the same order.

Fig. 2 illustrates the method of using the numbers. The axis of symmetry of the curve to be drawn passes through 12. The curve has been penciled in and the French curve is adjusted to it till a section of the French curve coincides with the curve to be drawn. This section is then inked in and the numbers on the French curve between which the inking is done are noted. In the case taken these numbers are 12 and 6. The French curve is now turned over and placed so that number 12 on the back coincides with the starting point, and the curves coincide for same distance. Ink in the curve from 12 to 6. The curve on either side of 12 as far as 6 is thus exactly symmetrical. Further sections may be taken on one side of the starting point and reproduced, exactly by means of the numbers, on the other side until the entire curve is completed. The graduations on the curve need not be put on very accurately.

Land Reclamation Scheme in India

A scheme is proposed at Lahore, India, by the Government to reclaim a large area of land on the Dutch plan. The Rann of Cutch is a seashore waste, with narrow inlets which would be closed, allowing the shallow water to evaporate. The saline deposits would be washed out by a great canal from the Indus. The application of scientific agriculture to the reclaimed land and the construction of a railway linking Karachi and Bombay would complete the enterprise.





The Value of Scientific Training.

BY PRES. CHARLES R. VAN HISE,
UNIVERSITY OF WISCONSIN.

IN considering this subject I shall speak of the practical value of such training, the intellectual development furnished by it, and the importance of scientific training to the nation.

During the last half century, and very largely within the past twenty-five years, a great transformation has taken place in the method of handling the industries, transportation, and commerce.

In earlier times in industries and commerce, the apprentice system obtained. In the days of Washington the surveyor was practically the only engineer and his training was in most cases acquired not in a school or college, but by practice as an assistant to another surveyor, so that even in engineering the apprentice system was the normal one.

Fifty years ago the only liberal education which could be obtained in this country was that furnished by the classical college. After having gained such education as this college could give, a man began as an apprentice in his chosen avocation, gaining the necessary knowledge from the experience of practitioners. To a large extent this was true even of medicine and of law. However, when it began to be realized that the apprentice system of education was both expensive in time and inefficient in accomplishment, the professional school arose in this country. The first of these professional schools were those in theology, medicine, and law. Later came schools of engineering, and more recently have arisen schools of agriculture, home economics, commerce, pharmacy, dentistry, etc.

During the last quarter of a century the schools of applied education, their scope, and the number of their students, have increased marvelously. This has been the natural consequence of the law of supply and demand.

Concurrently with the rise of schools of pure and applied science, and largely in consequence of them, has occurred an enormous increase in the variety, magnitude, and complexity of industrial and commercial enterprises.

At the present time the heads of business offices, transportation, manufactories and mines, are all asking for college trained men and especially men who, besides having the breadth of a general college education, have been further professionally trained with reference to some one pursuit, for instance, civil or mechanical engineering. These demands have increased so rapidly that to the present time the schools of applied science have been unable to supply a sufficient number of men having the necessary capacity and attainment. At the present time no one would attempt to practice the profession of an engineer without the training in pure and applied science, which are prerequisite to its successful pursuit. The United States is demanding the services of more trained engineers than any nation, and these men are to be demanded in ever increasing numbers.

Railroads, the great modern transporting agents, which have revolutionized commerce, have gridironed the country. They strike across the plains and plateaus, they follow the meandering streams, they burrow through the hills and mountains, finding no range too lofty for assault. The construction of these roads, their maintenance, and in large measure, their management, are in the hands of engineers. Upon the great lakes and on the rivers are hundreds of mighty steamers, many of which are larger than the largest ocean vessel a few years since. Upon the sea are mighty leviathans, some of them carrying a burden of thirty thousand tons. The design, construction, and control of these great vessels are in the hands of engineers. In many districts of the United States, the shafts, drifts, and rooms of the mines honeycomb the hills. The ore and coal abstracted from the earth meet in great metallurgical plants. The development of the mines, the abstraction of the ore, the design, construction, and management of the metallurgical plants are all the work of engineers.

Interlocking with all of these lines of development are the applications of electricity. Transportation by steam is now being paralleled by transportation by electricity, and this agent has become of especial importance where the population is dense. The great vessels are controlled by electrical machinery. In the mine such machinery is found over ground and under ground. By the agency of electricity the enormous quantities of heretofore unused energy of the waterfall are carried to the centers where light and power are needed.

Great electro-chemical manufactories have arisen. The telegraph, telephone, and electric light are everywhere an essential part of our civilized life. All these accomplishments are the results of the discoveries of the scientists and their application to life by the engineer.

Finally, at the present time in America the chemical industries are increasing in magnitude with amazing rapidity, and this has resulted in the demand for the chemical engineer.

In short, one cannot turn to any large enterprise, transportational, mining, or industrial, but that he finds their development to be the result of the brain of the engineer, and in these establishments the engineer is bearing the brunt of the work of their management.

The more thorough-going and far-reaching the training in pure science, the more efficient the engineer. The man who is to develop a mine must fully appreciate the complex problem before him if he does his work in an enlightened manner. The principles of physics and chemistry and mineralogy and geology he must know broadly and deeply, if he is to see that even the apparently lawless ore deposits conform to the universal orderliness of nature. The man who grasps this order, who understands what to expect from what he sees, must have a long and rigorous training in a wide range of the sciences.

Even if some of us are willing to live in the world without knowing its character or the laws which govern it, our happiness nevertheless depends at every point upon the applications of science. Of this there can be no doubt. The chief difference between the manner of living of the people of today and those of one hundred years ago is a result of the advancement of science and its application to the services of man. If time permitted, it might be pointed out how within the past century science has become the benefactor of mankind, but a few illustrations must serve our purpose in this connection.

If the calculation is bad which suspends a bridge across the Tay there is a great disaster in consequence. That science be applied to the bridges across the Mississippi, Missouri, East River, and Forth we imperatively demand. These striking illustrations are chosen because the consequences of the lack of correct science are at once conspicuous; but more important, far-reaching, and imperative is the demand that science be applied to the water supply and sewage of cities, to the construction of homes, to food inspection, to medicine. The suffering and deaths resultant from the lack of applied science in these matters are incomparably greater than in all forms of accidents combined. In the past the people gave no thought to these things because the deadly work was done in detail. Its causes were obscure, and the community was accustomed to the results, just as savages, because it is an everyday occurrence, regard a death by violence as wholly natural. But no longer are enlightened peoples content with this state of affairs and already marvelous progress has been made, and often in directions where it was least expected.

EDITORIAL COMMENT.

We regret that more credit was not given for the matter in the article entitled "Industrial and Portable Track" in our October issue, to the Ernst Wiener Co., 64 Broad st., New York, as practically all was secured from their latest catalog. We say this in justice to the above company who we only mentioned as using 24 inches as a standard narrow gauge track.

Photo from them did not arrive in time to make that article more complete.

The United States Civil Service Commission, Washington, D. C., announces the following examinations:

On January 4, 1907, to fill three vacancies in the position of magazine attendant at $2.00 per day at the Naval Proving Ground, Indian Head, Maryland.

On January 9th and 10th for topographic and cartographic draftsmen at $1,000 per annum in the office of the Chief of Staff, War Department.

On January 3rd and 4th for Civil Engineer in the Philippine service at $1,400 per annum.

Make applications by stating the time and position.

BOOKS AND CATALOGS.

Book Reviews.

THE STEEL SQUARE AS A CALCULATING MACHINE. By Albert Fair. 81 pages, illustrated, 12mo. cloth. Price 50 cents. New York: The Industrial Publication Co.

Any one who glances over this book must be struck with the number of difficult problems in all branches of mechanics that may be solved by the aid of the common steel square without any calculation whatever; and without any necessity for laying down elaborate diagrams. Hitherto the steel square has been looked upon as a tool used almost exclusively by carpenters, and its chief use was supposed to be the testing of the squareness of their work. It is now found, however, that this instrument enables us to lay out work with an ease and accuracy which few can realize, and that its use is not confined to carpenters alone, although for them it is indispensable. Even in the work of the plumber, where we would least expect it to be of general service, it is invaluable, as the following example, taken from the pages of the work before us amply shows: Suppose there were five or six pipes of various sizes leading from different parts of a house and all to discharge into one main pipe: What should be the size of the latter?

To make this calculation by the ordinary methods would be tedious, and to some it might be difficult; but the steel square enables us to solve it in a few seconds and without any calculation whatever.

Although there are in market several treatises on the steel square, there is none which explains the principle upon which the tool works, and unless the workman understands these principles he is liable to make the most curious mistakes. In the volume before us the explanations are full, clear and so simple that any intelligent boy can understand them, and put them in practice.

Catalogs.

The Lombard-Replogle Engineering Co., Akron, Ohio, are sending out Bulletin "A" of water wheel governors.

The Walschaert valve gear is illustrated and described in a catalog by the American Locomotive Co., New York City.

The B. F. Sturtevant Co., Hyde Park, Mass., have out a bulletin No. 131 on horizontal engines, showing parts and principal dimensions.

The horizontal unit cabinet and other office furniture is illustrated and described in a catalog from the Library Bureau, 530 Atlantic ave., Boston, Mass.

The Balanced Cable Crane Co. have an ideal system of transportation shown in a catalog issued by them from the office at 135 William st., New York City.

The Quincy, Manchester, Sargent Co., 114 Liberty st., New York, have issued a bulletin on riveters and show a large variety of machines in various work.

A catalog of text-books and industrial works for schools, colleges, engineers, architects, etc., has been issued by John Wiley & Sons, 43 East 19th st., New York.

The Warner Engine Co., Beloit, Wisc., have issued a catalog on the cut-meter, which is used in a large number of places for timing revolutions of machines using cutting tools.

The C. W. Hunt Co., West New Brighton, N. Y., have sent catalog No. 063 on coal handling machinery for power stations, boiler rooms, coaling stations, gas companies, coal yards, shipping docks, manufactories, etc. It contains a large variety of articles used in this class of work. Catalog No 053 describes the Hunt noiseless conveyor, used in a great variety of places.

The Green pneumatic hammers are described in a circular by the Dayton Pneumatic Tool Co., Dayton, O., and the uses to which these tools are placed are given in a complete table.

The Northern Electric Manufacturing Co., Madison, Wisc., have issued a catalog on dynamos and motors for industrial plant service and show a large variety of uses of these machines.

Coal handling machinery for mines is described in catalog No. 20 of the Jefferson Manufacturing Co., Dayton, Ohio, which is very full of illustrations and complete in description.

The Buckeye Electric Blue Printing Machines built by the Buckeye Engine Co., Salem, Ohio, are described in a very recent catalog which has for motto "Highest in Efficiency, Lowest in Price."

The Oliver Injector Co., Wadsworth, Ohio, have issued a catalog on their locomotive injectors, Garfield ejectors, the Ohio automatic injector, the Chicago sight-feed lubricators and grease and oil cups.

Automatic engine stop and speed limit systems are described in a catalog of the Lock Regulator Co., Salem, Mass. The illustrations show the application of these devices to many steam engines.

The American Injector Co., Detroit, Mich., manufacturers of U. S. and World injectors, have a lot of questions and answers in their catalog and other information that makes the booklet quite valuable.

The State Manufacturing Co., 36 Michigan street, Cleveland, O., have issued a catalog on Metla-Cota, which is a preparation for cleaning and coating the interior heating surface of steam boilers, plates or tubes.

The Brown-Cochran Co., Lorain, Ohio, have issued a catalog on gas and gasoline engines which are used in a great variety of places. They have also a catalog on refrigerating and ice-making machinery which contains quite a treatise on the subject of ice-making and refrigerating.

The Hawthorne Works of the Western Electric Co., Hawthorne, Ill., is described in an 8 x 10 catalog which they have issued. This plant consists of the following group of buildings: The office, the pattern shop, the pattern storage, the foundry, the forge shops and the machine shops, devoted to the manufacture of direct and alternating current motors and generators, and which are located west of the Belt Railway. The cable and rubber plants are located east of the railway. In addition to these buildings, there is a gas plant, water tower, power plant, two crematory buildings, freight house and round house for locomotives. The driveways connecting all the buildings are paved with concrete block.

ANUARY, 1906. VOL. V. NO. I.

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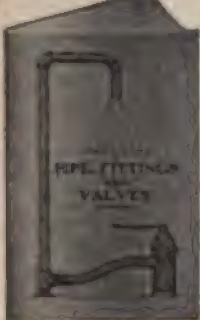

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More Draftsmen's Don'ts.

THE **don'ts for draftsmen recently published expressed very well some of my own ideas on the things that a draftsman should learn not to do. Here are some more which I feel should be more generally known by the drafting fraternity:**

Don't ever forget to put the scale on a drawing.

Don't fail to use stock sizes of drills, reamers, etc., when possible.

Don't leave out any data that should go on a drawing of a worm gear, bevel gear, etc.

Don't fail to index a drawing properly so that it can be found readily when wanted.

Don't make three or four different views of a piece when one or two views will do as well.

Don't use too many large words on a drawing, but use plain and simple language in all cases.

Don't scrape off dried ink from the inside of a ruling pen with a knife or any hard instrument.

Don't give the same dimension twice, for it is liable to lead to errors when this dimension is changed.

Don't allow any corrosion to take place on the inside of a ruling pen; it must be polished and lapped out smooth to ink well.

Don't forget to give on the drawing of a collar or pulley the direction it can be reamed or bored from to help assembling.

Don't give strange names to the parts of a machine, but in every case strive to name each in a way that shall tell its mission in the machine.

Don't put on too much fancy shading and lettering on shop drawings, but strive to make good, plain, clear drawings, with plain lettering in all cases.

Don't leave some dimensions to be gotten by adding a lot of other dimensions together or by subtracting them; all figuring should be done in the drafting room.

ANNOUNCEMENT

Beginning with the January issue, 1907, the name of this publication will be, THE INDUSTRIAL MAGAZINE, the management remaining the same.

The Browning Press

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Temperature and Pressure Controlling Devices a speciality. Write for circulars.

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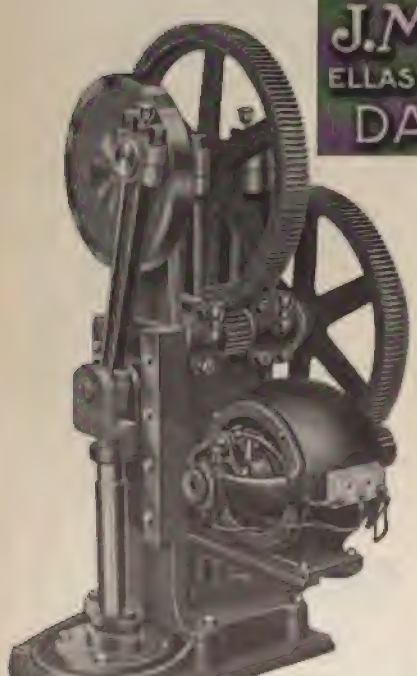

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ELLASTONE B'LD'G CLEVELAND, OHIO

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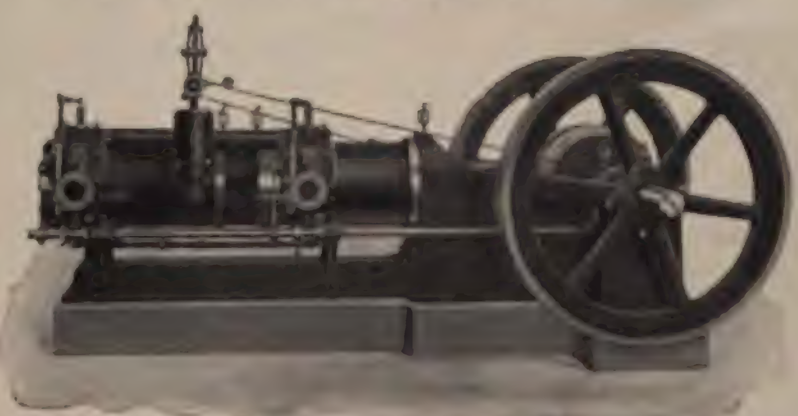
PLATES THAT TALK

CLASSIFIED LIST OF ADVERTISERS.



Classified List of Advertisers—Continued

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CONTRACTORS' SUPPLIES.

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CORE BINDERS

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CORE OVENS

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CRANES

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DERRICKS

DRAFTING ROOM FURNITURE.

DRAFTSMEN'S SUPPLIES.

DREDGES.

DRILLS, Air and Electric

DRILLS, and Rock

DRYERS.

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ENGINEERING INSTRUMENTS

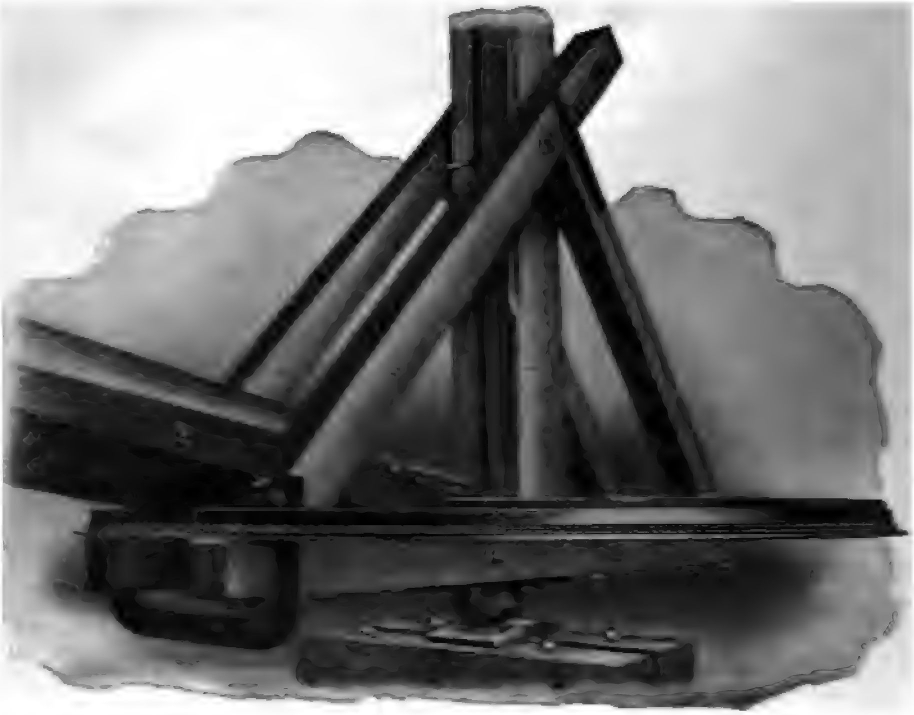
Classified List of Advdrtisers—Continued.

If you are in the market for machinery or supplies, write this magazine. We will have your inquiry sent to the proper concerns.

Contractors' Supplies.

LIST OF SUPPLIES.

Improved Derricks



THIS engraving shows the construction of Bull Wheels as used on all Terry Derricks in which Power Swinging [illegible] employed. The rim of the wheel is made of heavy [illegible] in attaching to derricks and in shipping [illegible] This permits of lowering the boom to [illegible] merely removing the swinging [illegible] as well as the angular braces that [illegible] that in taking off wheel it is only [illegible] the rim, and the bolts in timber-[illegible]

THE WOOD FRAMING NEED NOT BE DISTURBED.

[illegible] ***not necessary to take mast out of foot block,*** [illegible] mast step [illegible] ***through bolts only.*** [illegible]

THE TERRY & TENCH CO., Inc.

[illegible] Street and [illegible]xington Avenue, New York City.